

Managing Ideas: Commercialization Strategies for Biotechnology

by

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1. Introduction

Over the past three decades, the biotechnology industry has emerged as a vital and dynamic source of new technologies for the pharmaceutical and agricultural chemical industries. Moving beyond the overstated promise for early and widespread commercial success in the 1970s, biotechnology is now associated with a sustained flow of innovations and tools, offering dramatic improvements in human health and a compelling value proposition for health care and agricultural consumers.

Despite this transformation into a dynamic source of innovation, biotechnology firms have yet to displace market leaders in the pharmaceutical or agricultural chemical industries. For example, not one of the ten largest independent pharmaceutical firms in 1997 have their origins in biotechnology; indeed, seven of the top ten firms in 1997 were among the top fifteen leaders by sales in 1973, and all were established prior to the biotechnology “revolution” (Table 1). The fruits of biotechnology, however, are at the heart of new product introduction. By 1997, over 55% of all new products approved by the FDA are based, at least in part, on discoveries developed with the tools of biotechnology (Bioworld, 1998). In most cases, these are innovations of research-oriented biotechnology firms who choose to *cooperate* with at least one incumbent pharmaceutical firm in the commercialization process.

The combination of a highly dynamic technological environment and the persistence of market leaders in biotechnology contrasts with the “conventional” view – that small entrepreneurial firms reap the greatest profits from innovation by disrupting the competencies of existing firms. Taking advantage of the “gale of creative destruction”

has been suggested as the key drivers of competitiveness in high-technology sectors. Consider the hard disk drive industry. While market leaders innovated incrementally within each disk drive generation, new firms were responsible for commercializing each new *generation* of disk drives. They did this by targeting customer groups under-served by the value proposition offered by the leading firms for the “older” generation (Christensen, 1997). In other words, effective commercialization by entrants was achieved by exploiting a crucial blind spot of established firms, delaying the competitive reaction of these firms to new disruptive technology.

To be sure, innovation in both biotech and the disk drive are equally *radical*, exploiting new basic technologies to supplant existing products. Each disk drive generation rendered obsolete a previous generation; similarly, biotechnology innovation often consigns existing treatments to the annals of medical history. Indeed, by most standards, biotechnology innovation has been the more radical. Building on findings from the frontier of the life sciences, R&D teams employ scientists from disciplines and backgrounds distinct from those employed by the established industry.

Why, then, does innovation overturn market leadership in the disk drive industry but reinforce advantage in pharmaceuticals and agricultural chemicals? The crucial difference is the *commercialization environment* faced by start-up innovators in each sector. The *commercialization environment* – the microeconomic and strategic conditions facing a firm that is translating an “idea” to a product – determines the most effective *commercialization strategy*, the process for bringing innovation to the marketplace. The crucial element of a firm’s commercialization strategy is whether it competes or cooperates with established firms. Rather than differences in the nature of the technology

or in the superior awareness of pharmaceutical firms to disruptive threats, differences in the commercialization environment faced by start-up innovators create the different competitive dynamics in high-technology sectors.

Two key elements of the commercialization environment – the intellectual property regime and established firm ownership over complementary assets such as manufacturing expertise or distribution channels – drive the choices and strategies of effective start-up innovators. Specifically, widespread availability of formal intellectual property, combined with substantial expertise in regulation and distribution on the part of established players, makes transactions in the “market for ideas” an effective commercialization strategy for most biotechnology innovation. Though some analysts bemoan biotechnology companies’ lack of success in integrating forward and *competing* with established firms, long-term competitive advantage for most biotechnology firms may best be ensured by developing competencies at idea development alongside *strategic cooperation* with downstream commercialization partners.

Understanding the sources of advantage for biotechnology innovators creates a new managerial agenda. First, managers of both start-ups and established firms must develop and implement strategies that take advantage of the commercialization environment facing start-up innovators. Second, innovators must build their competencies for an environment where advantage need not be at the expense of the advantage of established firms. In other words, managers must learn that advantage derives not from the ability to disrupt established firms, but from the ability to offer a new and compelling value proposition for health care and agricultural consumers.

2. Contracting in Biotechnology¹

To understand the commercialization environment facing most biotechnology start-up innovators, recall the first major successful commercialization effort in biotechnology, the closely watched “race” to develop synthetic insulin in the late 1970s. Prior to the biotechnology revolution, Eli Lilly was the dominant supplier of beef and pig insulin. Though valuable, these products were inferior to pure human insulin, which could potentially be produced through the then-new tools of biotechnology. Partly as the result of encouragement by Lilly, three distinct teams undertook research programs aimed at expressing insulin, a precondition for commercial development. Two of the teams were university-based (at Harvard and UCSF), while the third effort was pursued by Genentech, then just the start-up firm of Herbert Boyer and Bob Swanson.

Competition was intense. The UCSF research team violated NIH rules regarding the use of genetic materials, and the Harvard team discontinued support for a well-regarded graduate student because of the inability to contribute successfully to the commercialization project (Hall, 1988, pp.176-78). While Genentech’s technical strategy differed from the university researchers (by explicitly avoiding NIH regulations), Genentech managers motivated their researchers on the basis of their competition with the other teams. A principal scientist recalled “...the name of Wally Gilbert [of the Harvard team] was in Swanson’s mouth all the time. That we had to beat him.” (Roberto Crea, quoted in Hall, 1988, pp.219).

In August, 1978, Genentech researchers announced the successful synthesis of the human insulin gene; the competition was over. Genentech filed a broad patent application

¹ This section draws on Stern (1995), and the references included therein.

and signed an exclusive license agreement with Lilly. By granting exclusive manufacturing and distribution rights to Lilly at this early stage, Genentech was able to take advantage of an opportunity for continued collaboration on scale-up activities. Though the race to develop human insulin was competitive, the commercialization strategy was focused around cooperation with the established market leader. Though uncertainty about how insulin would be commercialized existed and despite the fact that biotechnology represented a “radical” shift in the basis of drug discovery, Lilly and Genentech set out the pattern of contracting between new biotechnology firms and the established pharmaceutical industry persisting until the present day.² Rather than undermining Lilly’s traditional advantage, human insulin reinforced advantage for both Genentech and Lilly.

Contracting and cooperation with established firms continues to be the norm. As Carl Feldbaum, President of the Biotechnology Industry Organization (BIO), succinctly remarked “strength...is reflected in the proliferation of collaborations and partnerships, which are the lifeblood of biotechnology, as indeed many of you well know.... [This is unsurprising] given the phenomenal, almost exponential growth in biotech deals in recent years. In year 2000, there were five times as many new deals between biotechnology companies and pharmaceutical companies as in 1993.” (Feldbaum, 2001)

² Indeed, the extensive litigation between Genentech and Lilly about the terms of their contracting agreements, as well as their dispute over human growth hormone, has been an additional hallmark of the era of “contracting” between biotechnology innovators and downstream commercialization partners.

3. The Commercialization Environment: How Should Ideas Be Managed?

Start-up innovators who generate a new technology – a truly new “idea” – face a stark strategic choice about how to bring this product to the consumer. On the one hand, developing a value chain from scratch allows the innovator to enter the product market and compete directly with more established players. Alternatively, strategic cooperation with more established players – whether through licensing, an alliance or partnership, or perhaps even outright acquisition – allows the innovation to be directly integrated into an already functioning value chain but eliminates the possibility of displacing the established value chain through innovation.³

Commercialization strategy is thus one of the most crucial decisions a firm makes in terms of its ability to profit from technologies developed within the firm. Effective commercialization strategy results from careful analysis of the commercialization environment, weighing the benefits and costs of alternative strategies for securing profits and competitive advantage through innovation.

For most start-up innovators, the commercialization environment includes two elements crucial to the choice of commercialization strategy. First, the firm evaluates the relative cost and profitability of pioneering a new value chain compared to leveraging an established value chain. Second, the innovator assesses its ability to control the fundamental knowledge after the established firm becomes aware of the new technology.

³ For a given innovation, it is difficult for a start-up to pursue *both* strategies simultaneously. Not only do most firms lack the resources for a dual-track strategy, but some of the key elements of cooperation (e.g., open disclosure with established firms) are key hazards in a competition strategy (e.g., because disclosure allows established firms be imitate the competitive value proposition more quickly).

Together, these factors determine the potential for advantage under a cooperative or competitive strategy, shaping optimal commercialization strategy.

Consider the costs associated with effective new product introduction. To commercialize successfully, the innovator must acquire or access the manufacturing, distribution, and technology capabilities necessary to deliver value from the innovation to customers. These *complementary assets* are costly – many times the cost of the initial R&D associated with the innovation. In most cases, developing these capabilities requires a higher cost than integrating the new technology into an established value chain. For example, most biotechnology companies can expedite later-stage clinical trials by cooperating with firms experienced in managing the regulatory process. Even more saliently, traditional pharmaceutical companies can market new drugs through sophisticated distribution networks, often at a fraction of the cost that a biotechnology firm would face developing these capabilities from scratch. As well, many pharmaceutical firms hold some excess capacity in their capabilities for regulatory approval and distribution. While some biotechnology firms have developed these capabilities to a limited degree, recent consolidation among pharmaceutical firms has reinforced these traditional strengths; the average biotechnology start-up faces an even greater disadvantage in commercialization today compared to a decade ago.

The second crucial aspect to the commercialization environment facing a start-up innovator is the degree of *appropriability*, the ability to control the knowledge underlying an innovation after more established firms recognize its potential impact on the market. In the absence of effective intellectual property protection, start-up innovators face potential *expropriation* by market leaders. Established firms may imitate the new

technology without sharing their profits with the initial innovator. Box A discusses the challenges to avoiding the expropriation hazard in most high-technology environments. When expropriation is possible, negotiations to pursue cooperation by the start-up are particularly hazardous. Reaching an agreement usually requires detailed disclosure of technical information. This knowledge helps the established firm develop its own version of the new technology. The “due diligence” in most licensing or strategic alliance agreements prevents the start-up innovator from maintaining its core knowledge assets as a secret. In most cases, formal intellectual property – such as a well-defined patent or copyrighted source code – is the most effective mechanism to overcome the hazards associated with expropriation, particularly in the context of contracting negotiations.⁴ Though IP protection in biotechnology is not ideal by any means, the availability of effective and widespread IP protection is dramatically higher in this sector than in nearly any other sector of the economy (Cohen, et al, 2001); in contrast, in sectors subject to the gale of creative destruction, IP protection tends to be weak or non-existent for the key knowledge assets of start-up innovators.

4. Choosing the Commercialization Strategy

An effective commercialization strategy accounts for the *interaction* between these two key dimensions of the commercialization environment – the level of control over complementary assets and the knowledge embedded in the innovation. Figure 2 illustrates the framework, highlighting four potential cases. Combining the impact of complementary assets and intellectual property offers insight into how a firm might apply

⁴ Conversely, trade secrets are a more appropriate mechanism for avoiding imitation when competing with the established firms.

a commercialization strategy to suit its environment; as well, industries with particular environments will have distinctive competitive dynamics. Of course, though we discuss each environment in the “extreme” case, the commercialization strategy framework offers insight into more ambiguous environments, as a tool to evaluate how strategy shifts as the commercialization environment changes.

The Attacker’s Advantage

Consider an environment where weak IP protection coexists with a wide dispersion over the key complementary assets required for effective commercialization (the upper left-hand quadrant of Figure 2). At its heart, this is a “level” playing field between start-ups and established market leaders. While competitive commercialization does not require duplicative investment by the start-up (the established firm does not control the key complementary assets), the new technology can be easily imitated once the market leader recognizes the nascent threat.

In this environment, technological leadership is likely fleeting, and competition is likely to be intense. The development of new technology offers continual opportunities for start-ups to attempt to undermine existing market leadership; however, easy imitability gives most start-ups a very small share of the value created by their innovations.

Despite the poor prospects for competitive entry, this environment is even less conducive for cooperation. The very act of bringing the value of the technology to the attention of the current market leader weakens the position of the initial innovator, reducing its advantage from either cooperation or competition. In this environment, effective commercialization strategy requires tight integration between research and

commercialization. Continued market leadership depends on continued technological leadership, a prospect undermined by the potential for new start-up innovators to exploit the “competency traps” of existing market players. As the history of the disk drive industry bears out, sustainable advantage is difficult to secure, as leadership by any one firm raises a challenge to the pool of would-be start-up innovators.

Ideas Factories

Now consider an environment where invention precludes effective development by established firms but established firms maintain ownership of the complementary assets necessary for effective commercialization (the lower-right hand quadrant of Figure 2). Not only does the start-up innovator need to undertake duplicative investments to compete, but negotiations with the market leader need not undermine their basis of advantage. Effective commercialization strategy here results in the emergence of “ideas factories” – technological leaders focusing on research and commercializing through reinforcing partnerships with more downstream players.

The key issue becomes not whether to pursue a contracting strategy, but when and how. A key determinant of the return on innovation will be the degree of bargaining power controlled by the start-up innovator. Securing bargaining power can be achieved in several ways. First, the value offered by the technology must be clearly signaled and demonstrated (recall that disclosure undermines bargaining power when appropriability is weak). Second, to the extent possible, the start-up innovator plays off established firms against each another in a bidding war. In an ideal case, an ideas factory “auctions” off technology to the highest bidder, with high participation in the auction and low uncertainty over the value of the technology.

Rather than disrupting their advantage, ideas factories reinforce the basis of advantage for established by firm offering a fertile source of new innovation. A supply relationship with these specialized technology producers enhances competitive advantage, particularly when the ideas factory develops technology complementary to the existing value proposition. Indeed, established firms face new challenges in this environment. Balancing the commercialization of technologies developed both within and outside the firm requires a capacity for monitoring internal and external innovation.

Though the description highlights the extreme case, this quadrant comes closest to capturing the origins of commercialization strategy and industry dynamics in the biotechnology and pharmaceutical industries over the past quarter century. By and large, most biotechnology innovation is fairly well protected by formal intellectual property mechanisms, particularly when compared to innovation in other sector of the economy. At the same time, new biotechnology firms frequently form around the fruits of basic research in the university sector. They can discover new technology more easily than manage the commercialization process, including the regulatory hurdles, manufacturing requirements, distribution and branding. The pharmaceutical industry has more than adequate expertise in these complementary commercialization functions. While some opportunities for independent commercialization do exist, these usually occur in low regulatory environments and new market segments. For example, in developing Ceregen for the rare and previously untreatable condition of Gaucher's disease, Genzyme pursued independent commercialization. The relative cost was low, the drug fell under the *Orphan Drug Act*, and the potential patient base was easily identified because of the rarity and severity of the illness. The scarcity of such cases highlights a more general

insight; rather than cautiousness on the part of biotechnology entrepreneurs or a more sophisticated level of awareness on the part of pharmaceutical firms, the historical “inability” of biotechnology companies to integrate forward and *compete* with the traditional industry reflects a nuanced (and appropriate) approach to commercialization strategy.

Reputation-Based Ideas Trading

In the off-diagonal quadrants of the commercialization strategy framework, more subtle competitive dynamics come into play, reflecting the tradeoffs determining optimal commercialization strategy. When the disclosure problem is severe but incumbents possess critical complementary assets, there is a potential for gain through the market for ideas (since the start-up requires the complementary assets). However, a contracting solution is difficult to achieve. Essentially, weak appropriability tempts established firms to expropriate, discouraging start-ups from innovating in the first place.

A market leader can encourage start-up innovation in this environment by committing to *avoid the temptation of expropriation*. The key to commitment is *reputation*. Rather than exploiting all opportunities for gain in each transaction, a market leader offering a “fair” return to innovators can develop a reputation over time. This soft bargaining strategy by a market leader both encourages start-up innovation and positions itself as the most attractive potential partner for externally developed technology.

Indeed, such investments in reputation are routinely observed in the pharmaceutical industry. On the one hand, costly litigation, such as that between Amgen and Johnson & Johnson over EPO, likely diminished the reputation of Johnson & Johnson as a biotechnology collaboration partner, at least for a few years. In so doing,

Johnson & Johnson ceded a stream of external innovation to other established players. On the other hand, favorable terms, such as those routinely offered by Merck for the most promising external innovation, establishes reputational capital for the firm, which can be used to access the future innovations of smaller entrepreneurial firms.

Though relatively strong IP protection for biotechnology firms mitigates the centrality of reputation (compared to, for example, the role it plays in the telecommunications equipment industry, where Cisco's technology strategy is focused around the principle), biotechnology innovators often find themselves in a grey appropriability environment, raising the importance of such concerns.

Greenfield Competition

When control over complementary assets is dispersed and start-up innovators can preclude imitation, competitive interaction is similarly subtle. Overall, this is a favorable position for the start-up innovator, since returns on the product market will be high (imitation is difficult), but potential market power offers substantial bargaining power with potential partners.

In this environment, start-up innovators face tremendous opportunities. Unconstrained by past investments, they may consider multiple strategies for earning returns from innovation. However, it is important, even crucial, to note that such a favorable environment is the exception and not the norm. A small research-oriented firm can rarely acquire strong IP rights over a technology but for which no existing complementary assets offer the potential for competition under independent entry. Indeed, Genzyme's development of Ceregen may indeed satisfy this condition because of its unusual market. This example highlights a more general proposition. Though many

technology entrepreneurs fervently hope to protect their invention from competition, commercialization history suggests that IP rights are imperfect and competition more pervasive than apparent at first glance.

5. Managerial Implications

The commercialization strategy framework suggests that variations in how innovations are introduced across sectors result from differences in firms' commercialization environment. Indeed, systematic evidence bears out our main predictions (See Box B, "Is Commercialization Strategy Impacted by the Commercialization Environment?: Evidence from the Field"). This framework offers a new agenda for managers, based on taking advantage of opportunities arising in a given firm's commercialization environment.

An Agenda for Biotechnology Innovators

Biotechnology companies operate in environments characterized by complementary asset control by established firms alongside effective protection of the knowledge underlying their innovations. The origins of advantage most likely lie not in integrating forward into established markets but developing a core competence at innovation – building an efficient and effective "ideas factory."

In most cases, the key issue is not whether to cooperate with more established firms but how to position the technology to maximize the return on innovation. Rather than simply accepting that a large share of the returns on innovation flow to commercialization partners, biotechnology managers must ensure that their bargaining position in the market for ideas is as strong as possible:

- *Establish and signal an innovation competency.* Even today, most biotechnology inventions do not directly yield commercial advantage; even when regulatory issues are overcome, the value created by the innovation may not justify entering a new market. In the case of biotechnology research tools, many remain skeptical about the ultimate value of creating new commercialization opportunities. By developing a reputation for “high-quality” innovation, a biotechnology innovator can extract a much higher share of the returns from innovation. The key to establishing a reputation is judicious judgment in offering new technologies; in an environment where failure is common, reputational capital is built by acknowledging that only a few initiatives should be commercialized. In addition to developing credibility with downstream partners, this strategy also benefits recruiting efforts for top-quality scientific personnel, ushering in a cycle of rising innovation quality.
- *Negotiate with options.* The “price” for an innovation (or the terms of a strategic alliance) depends on the firms’ relative bargaining positions. Perhaps the single most important driver of bargaining position is the ability to play off multiple potential partners against one another. Even when a particular firm is an ideal partner, others may also express interest. Their presence confers bargaining power, raising the returns to the biotechnology firm on the innovation. Biotechnology innovators thus benefit by increasing their visibility to potential partners. Such activities include publishing well-known scientific articles, accessing the broadest

possible network (perhaps through a venture capital relationship), and nurturing the development of multiple relationships prior to striking a deal with a particular firm.

- *Choose the Timing of Cooperation.* Biotechnology commercialization takes place in a series of stages. From the earliest development and refinement of new technology, innovators pass through key regulatory hurdles and finally introduce a product to market by developing a manufacturing capability and distribution chain. They can establish cooperation with downstream partners at any of these stages. Early on, the uncertain value of the technology and range of alternative technologies weaken the bargaining position of the start-up innovator. Conversely, if cooperation waits until the latest stages, most biotechnology innovators will have incurred substantial investment costs, including navigating the regulatory process. Beyond the direct costs, bringing a new therapy through regulation diverts scientific personnel from their area of greatest productivity and consumes an overwhelming share of managerial attention. Consequently, most biotechnology innovators should initiate cooperation during the regulatory process. Evaluating the commercialization framework at each “stage” of commercialization provides an effective check, as the firm weighs the bargaining advantages associated with continued independence against the cost advantages associated with contracting.

An Agenda for Traditional Pharmaceutical Firms

For traditional pharmaceutical firms, accessing external innovation holds substantial potential value. We suggest several ways to manage the process of external innovation effectively.

- *Monitoring*: Pharmaceutical firms can position themselves as first-right negotiators by staying in touch with developments and projects undertaken by biotech start-ups. Such monitoring of progressing developments allows economizes on search costs for entrepreneurial firms and minimizes incentive to adopt more competitive commercialization strategies.
- *Developing and Exploiting Absorptive Capacity*: Just as internal links between research and other divisions of the firm are critical to bring products efficiently to market, so to is the replication of similar communication and other channels between start-ups and those internal divisions. Start-ups must consistently update and reorient their research towards the competencies of the established firm.
- *Encouraging Cooperation*: As potential for expropriation exists in some biotechnology situations, an incumbent should invest in developing a reputation as a fair ideas trader and should make commitments not to expropriate. Even “failed” deals should be perceived as resulting from “lack of fit” rather than expropriation. Once lost, reputation can be extremely difficult to re-obtain, requiring even more substantial concessions to future external innovators.

6. Concluding Thoughts

Though offering extraordinary promise and value, the record of competitive advantage in biotechnology has been mixed. Though some bemoan the inability of biotechnology firms to integrate forward and compete with established firms, the most likely basis for advantage is strategic cooperation with commercialization partners. As innovation and commercialization become increasingly global and intellectual property rights are expanded to allow firms more nuance in protecting their inventions, biotechnology managers must focus on their core competence – producing radical new technologies which dramatically improve human health. Perhaps ironically, the managerial agenda for biotechnology managers must be premised on a simple insight: advantage for most biotechnology innovators requires cooperating with precisely those firms who *might* have been their biggest competitor.

BOX A

Why is it so hard to make money from ideas?

The benefits of trading ideas – avoiding duplicative investments and softening product market competition – are compelling, making it difficult to see why start-ups pursue anything other than a cooperative approach. After all, no bargain will be struck unless it results in more profits than competition. However, a contracting path comes with its own risks and costs; certain advantages that might be ceded and never recovered.

The most fundamental challenge is the *paradox of disclosure*. Trading in “ideas” differs from traditional economic goods: the amount that buyers are willing to pay for an idea requires knowing the idea, but if a potential buyer knows the idea, she need not pay for it. Since potential buyers can always claim that they thought of the idea themselves, innovators find expropriation difficult to avoid. Even though disclosure increases a potential buyer’s intrinsic valuation (e.g., with no disclosure, the potential buyer cannot place *any* value on the idea), disclosure reduces bargaining power for inventors by a much larger amount. As such, the disclosure paradox reduces the returns to a contracting solution relative to pursuing a competitive product market strategy.

Fortunately, several mechanisms ameliorate the disclosure paradox. First, strong formal intellectual property protection prevents expropriation by giving the innovator a legal right to enjoin imitators from using their technology. Even when only weak intellectual property protection is available, potential buyers may commit themselves to non-expropriation, for example by signing non-disclosure agreements. When expropriation is a key wedge limiting established firms’ ability to access external technology, the established firm has an incentive to develop a reputation for “fairness” in the market for ideas. Third party “ideas brokers” may also play this role. For example, since individual venture capitalists have repeated interactions with established firms in particular sectors, such individuals often play a value-enhancing brokerage role by preserving the start-up’s bargaining power during negotiations (Robinson and Stuart, 2000; Hsu, 2000).

BOX B

Is Commercialization Strategy Impacted by the Commercialization Environment?: Evidence from the Field

Our framework suggests that the choice of cooperation versus competition depends on two critical variables: the ability to obtain intellectual property and whether internal control over complementary assets is cost-effective. In Gans, Hsu and Stern (2000), we provide a detailed empirical examination of two key hypotheses associated with this framework:

- Contracting is more likely in environments with stronger intellectual property protection
- Contracting is more likely in environments where control over complementary assets is less cost-effective

To test these propositions, we surveyed over 100 start-up innovators over five industry segments, examining the relationship between commercialization strategy and the commercialization environment. We relate the probability of cooperation (licensing, strategic alliance, or acquisition) to whether (a) the start-up innovator received a patent on the innovation and (b) the start-up innovator considered *control* over complementary assets to be a cost-effective mechanism for earning profits from their innovation. Table 3, which lists the probability of cooperation for each type of commercialization environment, offers an indication of our results. Cooperation is much more likely among firms who (a) were able to acquire intellectual property protection or (b) believed that control over complementary assets was not cost-effective for earning returns on innovation. From the least to most favorable environment, the cooperation probability increases over 400%. Moreover, these differences show up across industrial areas: segments such as biotechnology where intellectual property is strong and incumbent complementary assets are critical are associated with cooperation while segments such as industrial equipment where these conditions are less salient are more closely associated with competition. Overall, the framework offers a tool for evaluating how to effectively manage the commercialization process in a given economic environment.

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Table 1
PHARMACEUTICAL FIRM MARKET LEADERSHIP

Sales Rank, 1997	Company	Date Established	Sales Rank, 1973
1	Merck	17th century	2
2	Bristol-Myers Squibb	1887, 1856	9
3	American Home Products	1926	6
4	Pfizer	1848	7
5	Abbott Labs	1900	21
6	Eli Lilly	1876	11
7	Warner Lambert	1852	3
8	Baxter	1931	79
9	Schering-Plough	1851	15
10	SmithKline Beecham	1830	31

Sources: Corporate web sites; BioWorld 1998.

Table 2:
The Commercialization Strategy Framework

		Do incumbent's complementary assets contribute to the value proposition from the new technology?	
		No	Yes
Can innovation by the start-up preclude effective development by the incumbent?	No	The Attacker's Advantage	Reputation-Based Ideas Trading
	Yes	Greenfield Competition	The "Ideas" Factory

TABLE 3
 COOPERATION PROBABILITY
 BY COMMERCIALIZATION
 ENVIRONMENT

		Entrant's Cost of Acquiring Necessary Complementary Assets	
		Relatively Low	Relatively High
Number of Patents Associated with the Project	No patents	Pr (Cooperate) = 0.143 (<i>N</i> = 28)	Pr (Cooperate) = 0.308 (<i>N</i> = 13)
	At least one	Pr (Cooperate) = 0.346 (<i>N</i> = 52)	Pr (Cooperate) = 0.560 (<i>N</i> = 25)