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# The product market and the market for "ideas": commercialization strategies for technology entrepreneurs

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**Abstract**

This paper presents a synthetic framework identifying the central drivers of start-up commercialization strategy and the implications of these drivers for industrial dynamics. We link strategy to the *commercialization environment*—the microeconomic and strategic conditions facing a firm that is translating an "idea" into a value proposition for customers. The framework addresses why technology entrepreneurs in some environments undermine established firms, while others cooperate with incumbents and reinforce existing market power. Our analysis suggests that competitive interaction between start-up innovators and established firms depends on the presence or absence of a "market for ideas". By focusing on the operating requirements, efficiency, and institutions associated with markets for ideas, this framework holds several implications for the management of high-technology entrepreneurial firms.


*Keywords:* Product market; Commercialization strategies; Technology entrepreneurs; Ideas market; Appropriability

## 1. Introduction

The past two decades have witnessed a dramatic increase in investment in technology entrepreneurship—the founding of small, start-up firms developing inventions and technology with significant potential commercial application. Because of their youth and small size, start-up innovators usually have little experience in the markets for which their innovations are most appropriate, and they have at most two or three technologies at the stage of potential market introduction. For these firms, a key management challenge is how to translate promising technologies into a stream of economic returns for their founders, investors and employees. In other words, the main problem is not so much invention but *commercialization*.

Effective commercialization strategies seem to differ across industrial sectors. For example, in the early 1980s computer industry, Sun Microsystems' commercialization strategy involved direct entry into the workstation market. Sun's entry was mostly discounted by established firms such as Digital, IBM, and Apollo Systems, giving Sun the time to translate its overall technological vision ("the network is the computer") into a concrete series of technological, organizational, and market-positioning choices. As a disruptive entrant, Sun emerged as a leading computer hardware firm by building a novel value chain for high-end computer purchasers (Baldwin and Clark, 1997).

On the other hand, many technology entrepreneurs have secured extraordinary returns by integrating their innovations into an existing value chain, often

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involving intimate cooperation with established industry players. For example, in the interconnection technology segment, the profits earned by companies such as American Internet Corporation and Growth Networks are the result of an alliance strategy (and ultimately an acquisition) by the industry market leader, Cisco Systems. In the case of the 20-month-old closely-held Growth Networks, the US$ 355 million acquisition in 1999 secured a return for Growth Networks' stakeholders valued at over *US$ 5 million per employee* (New York Times, 2000). From the perspective of the established firm, Cisco has retained market leadership over several generations of novel technology and despite a turbulent industry slowdown in 2000 and 2001.

This objective of this paper is to offer a synthetic framework identifying the drivers of start-up commercialization strategy and the implications of these drivers on industrial dynamics. This framework links strategy to the *commercialization environment*—the microeconomic and strategic conditions facing a firm translating an "idea" into a valuable proposition for customers. By focusing on the commercialization environment, we can assess why companies like Sun exploit technological leadership to construct a novel value proposition and compete against incumbents, while companies such as Growth Networks work with established firms and leverage the *existing* value proposition. Our analysis suggests that the crucial factor determining patterns of competitive interaction between start-up innovators and established firms is the presence or absence of a "market for ideas". By focusing on the operating requirements, efficiency, and institutions associated with markets for ideas, we offer a framework isolating how start-up commercialization strategy depends on the economic environment.[2]

To understand the role of markets for ideas, consider the experience of Robert Kearns, the independent inventor of the intermittent windshield wiper in the early 1960s. Unable to commercialize on his own, Kearns approached senior engineers at the Ford Motor Company, disclosing both the operating principles and functionality of his invention. After some negotiation, Ford rejected a licensing agreement with Kearns, but introduced a similar technology to the market shortly thereafter. For over 20 years, Ford and other automakers declined to pay Kearns royalties on this invention; it was not until the 1990s that Kearns successfully upheld his patent and extracted a portion of the economic returns (Seabrook, 1994). In this case, the absence of a market for ideas reduced Kearns' ability to earn returns on his invention and, by setting a precedent, eliminated the incentives for start-up innovation in the automotive technology sector.

Markets for ideas play a crucial role in shaping commercialization strategy and industrial dynamics. In order to understand that role, we build upon and advance the agenda laid out in Teece (1986), emphasizing two central elements of the commercialization environment: the nature of the appropriability environment, and the distribution of ownership and control over specialized complementary assets, such as distribution and manufacturing capabilities, or a brand-name reputation. As Teece highlights, the innovator's share of the value created by her innovation will be smaller when appropriability is weak (due to imitation by competitors) or when specialized complementary assets are controlled by other players (due to bargaining among actors in the value chain). Using this framework, Teece illustrates how these factors shape the innovator's strategy choice, highlighting the role that "hold-up" can play in fostering integration between innovators and complementary asset owners.

In this paper, we focus on the specific challenges faced by technology entrepreneurs. Our framework is premised on the insight that, for many start-up innovators, those firms that control key complementary assets are precisely those that are the most likely and/or most effective potential product market imitators. This perspective refines Teece's analysis, where the challenges associated with contracting for complementary asset access were treated distinctly from the potential for imitation. In our reformulation, a principal hazard in pursuing cooperation with complementary asset owners is the possibility that these owners are current product market players with incentives to expropriate the innovator's technology and commercialize it themselves.

[2] This framework builds upon and complement our theoretical and empirical research examining incentives and equilibrium commercialization strategy for start-up firms (Gans and Stern, 2000, in press; Gans et al., in press). In contrast to this earlier research, here we attempt to combine a rich phenomenological understanding of technology entrepreneurship with a nuanced and explicitly strategic framework in order to assess how commercialization choice varies with the economic environment.

As a result, commercialization strategy for start-up innovators often presents a tradeoff between establishing a novel value chain and competing against established firms versus leveraging an existing value chain and earning returns through the market for ideas. For example, when considering how to commercialize the Navigator browser in 1995, Netscape considered a technology licensing agreement with Microsoft before committing itself to competing head-to-head with Microsoft by offering an independent cross-platform browser product. If Netscape had instead collaborated with Microsoft (allowing both firms to avoid the costly standards battle which ensued throughout the late 1990s), this cooperative strategy (and the details of that licensing agreement) would have taken place in the *shadow* of potential product market competition.

By focusing on a commercialization environment where established firms can both control complementary assets and serve as potential imitators, our framework offers several new insights into effective commercialization strategy, including the role that appropriability, reputation and economic institutions plays in shaping strategic choice, and the impact of commercialization strategy on competitive dynamics. For example, whereas most previous strategic analysis highlights the level of appropriability as a driver of strategic choice, our framework suggests that the key driver of effective commercialization strategy should be the "type" of appropriability (e.g. whether appropriability is based on formal intellectual property rights such as patents versus informal mechanisms such as secrecy). Even when tight secrecy offers a strong appropriability environment, transacting in the market for ideas will often undermine that secrecy and increase the potential for expropriation. In contrast, when the innovator controls formal IPR such as a patent, the potential for expropriation will be reduced, and the innovator is likely to find a cooperation strategy more attractive.

As well, this framework highlights the role played by reputation and institutions for ideas trading in "mixed" environments—when the appropriability environment and complementary asset environment place competing pressures on the start-up in terms of commercialization strategy choice. For example, when the established firm controls necessary commercialization assets but negotiation risks expropriation, effective strategy depends on a careful evaluation of the reputation of alternative established players. Moreover, since knowledge of reputation may be difficult for a start-up innovator to observe, the market for ideas may be facilitated by the use of intermediaries, such as venture capitalists, who undertake repeated transactions with incumbent players.

Finally, our framework offers insight into competitive interaction between start-up and established firms. Most prior research on the impact of start-up innovation considers a case where the principal commercialization option for entrepreneurs is to undermine the advantage of established firms in the product market (Foster, 1986; Henderson and Clark, 1990; Christensen, 1997). However, our framework explicitly considers how competing in the product market compares with cooperating established firms through the market for ideas. For example, to the extent that a weak intellectual property environment increases the *relative* returns to competition over cooperation, the potential for disruptive technologies to overturn established sources of market power is higher in environments with weaker intellectual property protection.

The next section describes the commercialization strategy choice facing technology entrepreneurs, highlighting industries and competitive environments where we tend to see one strategy or the other. Sections 3 and 4 then present a simple commercialization strategy framework, which considers how the nature of appropriability and the ownership of complementary assets interact to determine the elements of an effective commercialization strategy and competitive dynamics. We then turn to the strategic implications of this framework for technology entrepreneurs. Section 6 considers implications for public policy and future research in this area.

## 2. The product market versus the market for "ideas"

For many technology entrepreneurs, the commercialization stage is the first opportunity to truly define a firm's strategy and positioning.[3] Because of their

[3] While we recognize the crucial role played by the motivation and experience of founders in technology entrepreneurship and the challenges associated with accessing initial external financing for entrepreneurial firms, we abstract away from these issues to focus on commercialization strategy drivers. Essentially, our analysis is

limited financial and human resources, start-up innovators usually can only pursue a small number of strategic options at any one time without losing effectiveness in delivering consumer value (Bhide, 2000; Veugelers and Cassiman, 1999). While a start-up can occasionally make the transition from a competition to cooperation strategy and vice versa, there are costs and constraints on switching. For example, entry into the product market requires sunk investments that mitigate the gains from cooperation with established firms, and antitrust laws and regulatory issues may make collaboration more difficult after entry has occurred. Conversely, negotiations in the market for ideas entails substantial risk, requiring costly search and disclosures that confer power towards established firms. Even by testing the waters in ideas markets, start-up innovators may foreclose on the most profitable commercialization route. The choice between cooperation versus competition, therefore, requires a fine-grained ex ante analysis of the costs and benefits of each option.

### *2.1. Profiting from innovation through the product market*

Consider a start-up innovator intending to launch its product independently. Beyond the intrinsic value of the technology, profitability will depend on several factors. First, the start-up must develop key capabilities and acquire complementary assets to ensure that the innovation offers a novel customer value proposition. As well, profitability will be sensitive to the competitive strategies of incumbents, including the potential for aggressive price competition and the ability of established firms to quickly imitate the functionality of the start-ups technology.

Entering the product market sometimes offers an opportunity. Technology entrepreneurs may be able to develop competencies precisely because more established firms may be ineffective at organizing for and marketing new technological opportunities (Foster, 1986; Henderson and Clark, 1990; Christensen, 1997). A key implication is that established firms are at risk of losing their competitive advantage to the "gale of creative destruction". For example, as an early exploiter of the Internet, Amazon used emerging technology to shift the basis of competitive advantage in the bookseller market, posing a threat to dominant market players such as Barnes and Noble. When the complementary assets necessary for effective commercialization are themselves novel, prior market leadership may hinder effective exploitation of new technology.

To be sure, several difficulties confront technology entrepreneurs implementing a product market-focused commercialization strategy. The start-up innovator must undertake aggressive investments (such as in marketing or manufacturing), manage multiple dimensions of uncertainty, and focus scarce organizational resources on establishing a market presence. The start-up must simultaneously persuade customers of their novel value proposition while avoiding "detection" and an aggressive response by established players. For example, in the typesetting industry, several entrants have commercialized new technologies for creating pre-publication formatted written images. However, established market leaders—such as Linotype—have been the ultimate beneficiaries of these innovations in nearly all cases. Linotype's aggressive response to new competitive threats and their utilization of specialized complementary assets, such as font libraries, allow them to maintain continued market leadership in the face of changing technological leadership (Tripsas, 1997). In other words, a product market strategy requires that the technology entrepreneur offers an integrated value proposition and avoids detection and a competitive reaction from established market players.

### *2.2. Profiting from innovation through the market for ideas*

For a start-up innovator, the main alternative to competing directly in the product market is through a "cooperation" strategy. This strategy is composed of identifying and executing agreements with other firms—usually incumbents—who serve as conduits for commercializing technology to the product market. Essentially, the start-up chooses to earn returns on innovation through the market for ideas rather than

premised on the idea that financing has been available to develop a technologically successful invention, and that the entrepreneur is interested in maximizing the economic returns on this innovation. For an introduction to the broader issues associated with technology entrepreneurship see, for example, Roberts (1991), Bhide (2000), Shane (2001) and Lerner and Gompers (2001).

directly through the product market. The value of a cooperation strategy is determined by the "price" the start-up receives through negotiations in the market for ideas. While technology entrepreneurs face several delicate contracting hazards in the market for ideas, negotiations take place in the shadow of *potential* product market competition. That is, the value derived from cooperation increases with the threat posed by the start-up innovator to the product market position of the established firm.

Cooperation strategies take several distinct forms.[4] On the one hand, the start-up can formally license intellectual property to one or more ideas buyers. Under licensing, each ideas buyer has the right to exploit the start-ups innovation, receives technical assistance according to the terms of the agreement, and pays according to a fixed fee, royalty or more complex payment agreement. While the optimal structure of a license depends on features of the technology and contracting environment, the key element of licensing is that both the start-up and licensees cooperate in commercialization while maintaining organizational independence.[5] At another extreme, the markets for ideas may operate through acquisitions of start-up innovator by established firms (Blonigen and Taylor, 2000). Over the past decade, acquisition has come to play an increasingly important role and now accounts for the *majority* of financial returns realized by venture capitalists (Gompers, 1995; Black and Gilson, 1998). Under acquisition, a technology entrepreneur not only foregoes independent commercialization for current technology but cedes control over their organization to incumbent players. As well, "intermediate" contracting relationships are possible, from joint ventures to strategic and "educational" alliances to milestone financing (Roberts and Berry, 1985; Oxley, 1997). Each of these modes for cooperation involve subtle nuances. For example, whereas the returns from licensing are shaped by the value of the technology itself, the returns from acquisition depend also on the quality and coherence of the technical team. The key point is that any form of a cooperation strategy has the impact of limiting investment by the start-up in downstream commercialization, muting potential product market competition between start-up innovators and incumbent firms.[6]

Commercializing through the market for ideas confers several benefits, allowing buyers and sellers of technology to soften downstream product market competition, avoid duplicative investment, and engage in complementary technology development.[7] First, cooperation reinforces established market power and softens market competition. Since the total

[4] An extensive literature in economics and the management of technology addresses the mode of cooperation between a research-oriented innovator and a downstream market player. Much of this literature builds on the more general economic analysis of arms-length contracting versus integration (Williamson, 1985; Hart, 1995; Aghion and Tirole, 1994). A number of researchers in strategic management attempt to gauge the impact of transaction costs and other factors on the management of innovation relationships, particular after a technology has already been developed (Pisano, 1991; Chesbrough and Teece, 1996; Pisano et al., 1988; Arora et al., 2001). Overall, the choice between licensing, acquisition joint venture or alliance depends on an analysis of the incentives to maintain control over the technology for future development versus the benefits of ownership for those with direct control over commercializing the innovation. While the choice of cooperation mode is crucial for earning maximal returns on innovation, this paper highlights the broader choice between cooperation and competition, so detailed analysis of cooperation mode is beyond the scope of the paper.

[5] An extensive literature evaluates the structure of optimal licensing contracts in different environments. While this literature has been mostly theoretical (Katz and Shapiro, 1985; Kamien and Tauman, 1986; Kamien, 1992; Wang, 1998; Saracho, 2002), a systematic empirical literature has emerged in recent years (Lerner and Merges, 1998; Anand and Khanna, 2000).

[6] While firms may attempt to execute on a "dual-track" strategy, technology entrepreneurs usually lack the financial, management, or organizational resources to pursue two tracks simultaneously (Bhide, 2000; Veugelers and Cassiman, 1999). As well, elements of an effective product market strategy (such as avoiding detection by the established players) conflict with key elements of an effective ideas market strategy (such as broadcasting the value of the innovation).

[7] Our analysis of the benefits and costs of profiting from innovation through the market for ideas builds on a large body of important prior work, most of which (a) evaluates the role of technology markets without an explicit comparison to a product market competition strategy and (b) does not focus on the specific challenges facing technology entrepreneurs. Building on the seminal work of Teece (1986), this literature examines a range of issues, including the impact of the contracting environment and the nature of knowledge on the distribution of innovative activity (Pisano, 1991; Pisano and Mang, 1993; Arora and Gambardella, 1994; Arora, 1995). As well, recent theoretical work in economics emphasizes the role of technology markets in shaping innovation incentives and the distribution of rents from innovation (Anton and Yao, 1994; Aghion and Tirole, 1994; Gans and Stern, 2000). For a useful introduction to this literature (see Arora et al., 2001).

profits associated with competition are lower than the profits associated with monopolization, choosing a cooperative path preserves industry rents precisely because it subverts potential competition. When Bell and Western Union engaged in their epic battle for the emerging local telephone service market in the 1870s, neither firm was able to implement a profitable business model while the other was competing. This head-to-head competition continued until 1879, at which time a cooperative agreement was reached in which Western Union ceded control over commercialization of the telephone to Bell in exchange for a 40% equity stake and promises that Bell would stay out of the telegraph business (Smith, 1985).

As well, transactions in the market for ideas allow start-up innovators to avoid sunk investments in complementary assets necessary for commercialization (Teece, 1986). At the same time, established firms avoid investments in imitative research programs necessary for "catching-up" to the new market entrant (Gans and Stern, 2000). Finally, the availability of a market for ideas provides incentives to develop innovations reinforcing the value of current technology. For example, companies such as Intel spend considerable resources explicitly encouraging the *external* development of complementary technology (Gawer and Cusumano, 2002).[8]

However, several forces *counter* the benefits from contracting, discouraging collaboration between technology entrepreneurs and more established firms, and increasing the relative returns to a competition strategy. Perhaps the most fundamental friction arises from the *paradox of disclosure* (Arrow, 1962; Anton and Yao, 1994). Simply put, when trading in ideas, the willingness-to-pay of potential buyers depends on their knowledge of the idea, yet knowledge of the idea implies that potential buyers need not pay in order to exploit it. Disclosure increases the buyer's intrinsic valuation but reduces the inventor's bargaining power In the absence of formal intellectual property, potential buyers can claim that an idea was known, expropriating innovators once they have disclosed their technology. After Robert Kearns demonstrated the operation and functionality of the intermittent windshield wiper, Ford had incentives to exploit this idea without compensating Kearns for his technology. Because the disclosure of ideas shifts bargaining power from the sellers to the buyers of knowledge, the severity of the disclosure problem reduces the returns of technology entrepreneurs in the market for ideas relative to a product market competition strategy (Gans et al., in press).

The disclosure problem can be ameliorated if precise intellectual property rights are available or if the innovator can maintain effective bargaining threats. When intellectual property protection is available (e.g. through strong patent protection), disclosure does not detract from the owner's ability to profit from it. Unfortunately, for most technologies and industries, intellectual property protection is highly imperfect, leaving potential ideas sellers vulnerable to expropriation. However, when many partners are potentially available, start-up innovators can credibly threaten to pursue their idea with a third party when conducting bilateral negotiations with a particular established firm. The start-ups ability to threaten pervasive disclosure increases their bargaining power and so reducing the degree of expropriation (Anton and Yao, 1994, 1995). More generally, the operation and effectiveness of a market for ideas depends crucially on whether start-up innovators can credibly threaten to compete with potential partners.

At the same time, technology entrepreneurs must overcome the costs of identifying and accessing appropriate partners. Established firms are often reluctant to even begin negotiations with start-up innovators, discounting the potential commercial value of external technology. When the costs of gaining an "audience" with established market players is high, the relative returns to independent commercialization increases. Over the past decade, venture capitalists seem to have played an increasingly important role in developing markets for ideas in various market segments, connecting portfolio companies to a network of established firms, and so lowering the costs for start-up innovators of pursuing cooperative commercialization activity (Aldrich and Zimmer, 1986; Robinson and Stuart, 2000; Aoki, 2000; Hsu, 2002).

[8] Our perspective differs from those who suggest that the relationship between start-up innovators and established firms depends simply on the "nature" of technology (Chesbrough and Teece, 1996). Our analysis suggests that technology choice is, at least in part, under the firm's control and so is an endogenous outcome of the commercialization environment. In other words, when entrepreneurs expect to cooperate, their innovations will complement rather than cannibalize the incumbent value proposition.

## 3. The drivers of start-up commercialization strategy

Overall, both product market competition and cooperation strategies involve substantial risks and confer distinct benefits, raising crucial questions: How do start-up innovators choose between alternative commercialization strategies? What considerations guide the execution of the chosen strategy? How do these strategies impact upon overall competitive dynamics? The remainder of this paper addresses these questions by considering how a technologically successful start-up innovator chooses commercialization strategy when there are strong incumbent firms in the product market. We highlight this case for expositional simplicity in order to derive how the commercialization environment drives commercialization strategy choice and patterns of interaction between start-up innovators and established firms. Our analysis so far suggests focusing on two subtle yet crucial elements of the commercialization environment:

- *Excludability environment*: To what extent can successful technological innovation by the start-up preclude effective development by an incumbent with knowledge of the innovation?
- *Complementary asset environment*: To what extent does the incumbent's complementary assets contribute to the value proposition of the new technology?

### *3.1. Excludability (can successful technological innovation by the start-up preclude effective development by an incumbent with knowledge of the innovation?)*

Perhaps the key potential hazard facing a start-up innovator is the potential for expropriation by potential ideas buyers. To mitigate this hazard, not all appropriability mechanisms are equal. Appropriability mechanisms such as speed-to-market or traditional trade secrecy will usually be ineffective as mechanisms for *excluding* more established firms in the context of a cooperation strategy. Even when trade secrecy is effective for avoiding imitation by competitors, it may not be effectively used to preclude development by a potential partner, since disclosure is necessary for trade in the market for ideas. In contrast, two alternative appropriability mechanisms—intellectual property protection and technology design—may allow a firm to disclose technology while preserving bargaining power. For example, even when patent or copyright protection is modest, the ability to use litigation to temporarily halt the activities of an expropriator provides incentives for potential users to reach an agreement with the entrepreneur (Shapiro, 2001).

Similarly, certain technology designs have the benefit of displaying functionality while masking details that would allow imitation. Consider object-oriented software. For older programming languages, such as Fortran and Cobol, evaluating the logic of a given program necessitates examining the source code of the program. Perhaps not surprisingly, these languages flourished when most software development was either conducted in-house or in the context of ongoing relationships between vendors and users. However, over the past 20 years, object-oriented programming languages such as C++ and Java have achieved dominance. In addition to their substantial engineering benefits, object-oriented programming languages allow the precise logic underlying an application to be demonstrated (by revealing the object code) while withholding the source code necessary for imitation. Though reverse engineering is possible, imitation remains costly. This specific *form* of trade secrecy (incorporating non-imitability into the design) allows a start-up innovator to exploit the cost and market power advantages of cooperation without unduly placing itself in a weak bargaining position. Of course, even with strong intellectual property protection or with a strong design, imitation is often possible after some period of time. However, these mechanisms confer a *relatively* high cost on potential imitators who become aware of new technology, and so increase the attractiveness of strategies which require disclosure of functionality.

### *3.2. Specialized complementary assets (does the incumbent's specialized complementary assets contribute to the value proposition from the new technology?)*

As Teece (1986) has emphasized, the control over costly-to-build complementary assets is a key wedge between the capabilities of the start-up and more established firms in an industry, and the inability to

acquire these resources cost-effectively has an important impact on the returns earned by a start-up innovator. Specifically, when specialized complementary assets are required, the sunk costs of product market entry become substantial. This both reduces the returns to competition and weakens the relative bargaining position of the start-up when contracting with established players.

Under a product market competition strategy, the costs associated with duplicating specialized complementary assets held by established firms are entirely borne by the technology entrepreneur. However, under a cooperation strategy, the gains from trade will include the avoidance of costly duplication of investments, and these gains will be shared between the partners in the collaboration. Consequently, when considering commercialization strategy choice, an increase in the importance or concentration of control of complementary assets raises the *relative* returns to cooperation over competition (Gans and Stern, 2000). Thus, even though an increase in the importance of complementary assets reduces the absolute share of total value earned by the innovator (Teece, 1986), this factor will tend to encourage collaboration with more established firms over direct and independent entry into the product market.

## 4. The impact of the commercialization environment on strategy and competitive dynamics

Effective commercialization strategy results from the interaction between the excludability and complementary asset environment. These two factors define four distinct commercialization environments, each of which is examined in this section. Our analysis is encapsulated in Tables 1 and 2. In Table 1, we highlight the overall pattern associated with each commercialization environment. Table 2 summarizes the strategic choices facing start-up innovators and established firms in each environment, and the implications of these strategies for competitive dynamics.

Overall, our approach to identifying the drivers of commercialization strategy for technology entrepreneurs refines Teece's classical analysis (Teece, 1986), where the hazards associated with contracting for complementary asset access are treated distinctly from the potential for imitation. In our formulation, a principal challenge in pursuing cooperation with complementary asset owners arises from the fact that ownership is concentrated among incumbents with incentives to expropriate the innovator's technology. By focusing on this specific (but empirically common) case, our framework provides insight into the differences across technologies and industries in the strategic challenges facing technology entrepreneurs.

### 4.1. The attacker's advantage

Consider an environment with poor intellectual property protection and where incumbents do not control the complementary assets necessary for effective commercialization. In this environment, start-ups and established firms face off on a "level" playing field. Start-up investments in the product market need not be duplicative and are often modest in size. However, technological leadership will likely be fleeting: established firms have the opportunity to imitate once they recognize the nascent threat. Under these conditions, competition is likely to be intense, with continual entry challenges by start-ups aimed at undermining the value of existing market leadership positions. While

Table 1
Commercialization strategy environments

| | | 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 | Ideas Factories |

Table 2
The impact of the commercialization environment of strategy and competitive

| | Overturns Incumbent Asset Value | | Reinforces Incumbent Complementary Assets | |
|---|---|---|---|---|
| Non-Excludable Technology | **ATTACKER'S ADVANTAGE** | | **REPUTATION-BASED IDEAS TRADING** | |
| | *Start-Up Strategies*<br>• Few opportunities for effective contracting<br>• Opportunity to exploit technical leadership to capture market leadership<br>• Performance depends on 'stealth' product market entry | *Incumbent Strategies*<br>• Competitive advantage in products not competencies<br>• Sustained market position requires continual reinvention and preemption<br>• Constant monitoring and tight integration of value chain | *Start-Up Strategies*<br>• May be few opportunities for contracting<br>• Product market entry risky due to high costs and imitation risk<br>• Performance depends on existence of incumbent commitment to ideas trading | *Incumbent Strategies*<br>• Competitive advantages in both competencies and products<br>• Opportunity for sustainable positioning by developing reputation for ideas trading<br>• Often results in internal R&D focus |
| | *Expected Competitive Dynamics*<br>• Market leadership determined by technological leadership<br>• Established firms face competition from entrants in 'niche' markets<br>• Start-ups will make new investments in complementary assets as part of establishing a novel value proposition | | *Expected Competitive Dynamics*<br>• Relative market and technological stability<br>• Established firms face few competitive threats from start-up firms<br>• Start-ups may play a greater role if incumbent chooses reputation strategy | |
| Excludable Technology | **GREENFIELD COMPETITION** | | **IDEAS FACTORY** | |
| | *Start-Up Strategies*<br>• Ideal opportunity to choose between contracting and product market entry<br>• Opportunity to use temporary monopoly power to build future positioning<br>• Performance depends on strength of technological competition | *Incumbent Strategies*<br>• Competitive advantage is based on products not competencies<br>• Sustained market position requires continual innovation and ceding profits to upstream providers<br>• Develop reputation from strong innovative performance | *Start-Up Strategies*<br>• Contracting with established firms<br>• Product market entry is very costly and perhaps impossible<br>• Performance depends on securing bargaining power | *Incumbent Strategies*<br>• Competitive advantage is in competencies not products<br>• Sustained market position requires securing start-up partners<br>• Find balance between internal development and use of external start-up innovation |
| | *Expected Competitive Dynamics*<br>• Technological leadership drives rent distribution along the value chain<br>• Start-ups and incumbents compete for technological priority<br>• Substantial investments in new platforms and complementary assets | | *Expected Competitive Dynamics*<br>• Frequent changes in technological but not market leadership<br>• Start-ups compete with one another for priority in negotiations with incumbents<br>• Start-up innovation will reinforce existing platforms | |

entrepreneurs have an opportunity to overturn established positions, easy imitability gives most start-ups a very small share of the value over the long-term.

In this environment, start-ups have an opportunity to capture market leadership by effectively developing and diffusing competence-destroying technology. That is, smart attackers have an advantage in the commercialization process (Foster, 1986). At the same time, there are few opportunities for contracting with current market leaders. Not only does the current market leader have little to offer the start-up, 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, "stealth" is a crucial element of an effective competition-oriented commercialization strategy by a technology entrepreneur.

The key to a stealth strategy is to position the technology in the market in order to exploit the "blind spot" of current market leaders (Foster, 1986; Henderson and Clark, 1990). For example, incumbents often seem to overestimate the potential for further improvement from existing technologies at the expense of recognizing the growth path associated with emerging technologies emphasizing new performance characteristics. In his careful study of the hard disk drive industry, Christensen (1997) finds that while market leaders innovated incrementally in each generation of disk drives, new firms were responsible for key product introductions for each *new* disk drive generation. Though established firms had the means and technical freedom to commercialize new products (e.g. no firm could exclude others from switching to a "smaller" disk drive form factor), start-up innovators were able to exploit low barriers to entry and the availability of multiple market niches. Specifically, Christensen finds that successful commercialization of these disruptive innovations was accomplished by careful positioning of the new technology towards underserved customer groups. Established firms focus on responding to the needs and requirement of current customers made them particularly vulnerable to entry emphasizing new customer segments. In other words, given the commercialization environment in the disk drive industry, effective start-up commercialization was achieved by exploiting the inertia of established firms.

Ultimately, an environment with high imitability and low dependence on existing complementary assets implies tight integration between research and commercialization. Intense competition forces firms to invest in risky R&D and take advantage of "competency traps" in order to establish a novel value proposition for the industry. Technological leadership results in temporary market leadership, which is itself vulnerable to additional waves of entrepreneurial innovation via creative destruction.

### *4.2. Ideas factories*

Standing in complete contrast is an environment where successful invention precludes effective development by more established firms but those firms control the complementary assets required for effective commercialization. In this environment, we expect the emergence of "ideas factories"—technological leaders focusing on research and commercializing through reinforcing partnerships with more downstream players (Pisano and Mang, 1993; Arora and Gambardella, 1994; Gans and Stern, 2000). Not only would the start-up innovator need to undertake duplicative investments under a competition strategy, but negotiations with established firms do not unduly threaten the start-ups control over the technology.

The key issue is no longer whether to pursue a cooperation strategy but when and how. In this environment, the return on innovation will depend on the bargaining power of the start-up innovator, which can be enhanced in several ways. First, the value offered by the technology must be clearly signaled and demonstrated (in contrast, note that disclosure undermines bargaining power when appropriability is weak). Second, the start-up innovator might be able to play established firms against each other 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 firms by 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.

Table 3
Pharmaceutical firm market leadership

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

Sources: various corporate web sites; BioWorld Publishing (1998).

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 (Cohen and Levinthal, 1989; Rosenberg, 1990).

When markets for ideas exist, a high rate of innovation by start-up research-oriented firms is associated not with creative destruction but with the *reinforcement* of incumbent market power, a pattern exemplified by the biotechnology industry. While the radical technical and scientific breakthroughs promised by biotechnology were heralded originally as a force for creative destruction (United States Office of Technology Assessment, 1984), market leadership has remained relatively constant in the pharmaceutical industry over the past 25 years. 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 15 leaders by sales in 1973, and the remaining 3—Abbott, Baxter, and SmithKline Beecham—all have their origins in the traditional pharmaceutical business (Table 3). This is not to suggest that biotechnology products have not been commercialized. Indeed, 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 Publishing, 1998). In most cases, these are innovative outputs of research-oriented biotechnology firms in collaboration with at an incumbent pharmaceutical firm in the commercialization process.

Consider the "race" to develop synthetic insulin in the early years of biotechnology (Hall, 1988; Stern, 1995). Eli Lilly, the dominant incumbent supplier of beef and pig insulin, encouraged three separate teams to undertake research to express the insulin gene, a precondition for commercial development of human insulin. Two of the teams were university-based (at Harvard and UCSF), while the third effort was pursued by Genentech, a venture-backed start-up biotechnology firm. In August, 1978, Genentech researchers successfully synthesized the human insulin gene after an intense competition, ending the technology race. Within a day after the research was validated, Genentech filed a patent application and signed an exclusive license agreement with Eli Lilly to cooperate in commercialization.[9]

Despite a competitive race to develop the technology, commercialization itself occurred through cooperation. Even though the role that biotechnology firms would play in the pharmaceutical industry was unclear at that point, Lilly encouraged this external research, willing to risk the potential for competition in order to earn gains in the market for ideas. Indeed, rather than undermining the competitive advantage of pharmaceutical firms, biotechnology firms came to reinforce and sustain those advantages.

### 4.3. Reputation-based ideas trading

The above environments have well-defined patterns of competitive interaction because both the disclosure and complementary asset environment reinforce the same strategy—either competition (when incumbent complementary assets are not valuable and the disclosure problem is severe) or cooperation (when incumbent complementary assets are valuable and the disclosure problem is less severe). However, when considering the off-diagonal elements of our framework, more subtle forces come into play, reflecting the tradeoffs determining optimal commercialization strategy.

[9] While Lilly had initially encouraged this race between external R&D teams, Lilly was a strong negotiator, de-emphasizing their need for the technology and questioning its commercial viability (Hall, 1988, p. 230). As well, though the collaboration was initially a success, the relationship ultimately soured; Genentech and Lilly engaged in a long and costly litigation battle over the distribution of rents from this innovation.

Consider an environment where the disclosure problem is severe but incumbents possess the complementary assets necessary for effective commercialization. Though a market for ideas would confer a potential mutual gain (since the start-up innovator avoids investing in duplicative assets and the established firm reinforces their advantage by controlling the technology), a cooperative solution is difficult to achieve. In capital-intensive industries such as automobiles or aircraft, established firms are tempted to expropriate technology revealed to them, such as Bob Kearns' intermittent windshield wiper. This expropriation discourages start-ups from pursuing collaboration as a strategy and additionally discourages research in the first place (since competition is also likely to be unprofitable). Though the automobile industry invests heavily in internal R&D, very little innovation results from technology entrepreneurship. Since entrepreneurs and investors (rationally) expect start-up innovators to face great difficulties in appropriating the returns from their innovation, the auto industry has been bypassed in the venture investment boom of the past decade (Gans and Stern, in press).

As a result of these difficulties, established firms in this environment have an incentive to invest in mechanisms to enable a market for ideas. Rather than exploiting all opportunities for gain in each transaction, an established firm can develop a reputation for "fairness", thus, encouraging future start-ups to approach them with promising new technologies. Incumbent firms that succeed in establishing relational research contracts will be able to profit from the commercialization of new technologies at a higher rate than their competitors (Greif, 1994; Baker et al., 2002). In other words, while a "low" equilibrium exists in which established firms expropriate and, thus, discourage start-up innovation (as in the auto industry), there also exists a "high" equilibrium where incumbents foster a reputation for ensuring mutual advantage from the acquisition of external innovation.

Cisco Systems has perhaps undertaken the most ambitious strategy in this regard (Bunnell and Brate, 2000; Charles River Associates, 1999). Since the early 1990s, Cisco has committed to a strategy in which internal R&D activities are modest and the acquisition of new technology is systematized. For example, Cisco first undertakes a strategic alliance or partnership with firms that are ultimately acquired. Moreover, when alliances do not result in an acquisition, Cisco maintains positive relations with the firm and has mostly avoided litigation over the ownership or control of jointly developed technologies. As a result of these investments, Cisco receives unfettered access to the financial information, personnel, and customers of acquirees during the course of evaluating a potential deal. In contrast to other firms undertaking acquisition in the industry, Cisco is able to conduct interviews with key employees and customers without senior management present. While the downturn in the networking industry during 2001 has raised concerns about Cisco's ability to sustain this reputation-based strategy (since they cannot "promise" an ever-rising share price or a no-layoff policy), Cisco's reputation during the late 1990s seems to have allowed them to value start-up technologies more effectively and increase their ability to integrate external technology (Bunnell and Brate, 2000).

In their careful study of the management of external innovation at Intel, Gawer and Cusumano (2002) document a range of practices reinforcing Intel's reputation in the market for ideas. Senior managers at Intel responsible for relationships with external innovators have explicit incentives to encourage the *growth of the worldwide semiconductor industry* (rather than Intel's current profits). By providing industry-based incentives for the managers negotiating contracts in the market for ideas, Intel signals start-up innovators its commitment to attempt to avoid short-term expropriation in the interest of longer-term relational contracting. However, despite substantial investment and attention to this area, Intel has been accused of expropriation by some firms, particularly those with technologies relevant for Intel's core microprocessor business. In other words, even when a firm has substantial incentives to invest in reputation and senior management commits to this strategy, execution may be difficult to achieve across all of the expropriation opportunities available to a dominant market player.

Several complementary mechanisms may also underpin the functioning of markets for ideas in environments where excludability is weak but the gains from collaboration between entrepreneurs and established firms is high. For example, since individual venture

capitalists have repeated interactions with established firms in particular sectors, such individuals have come to play a crucial role as brokers, preserving start-up bargaining power during negotiations and allowing for more efficient pursuit of opportunities on the part of established firms (Robinson and Stuart, 2000; Hsu, 2001). Indeed, prior to the rise of in-house industrial laboratories in the early 20th century, patent brokerage was a key route through which new technologies were commercialized (Lamoreaux and Sokoloff, 1999).

Finally, in some sectors, more formal institutions have arisen to overcome the expropriation hazard. For example, in the musical recording industry, individual agreements between songwriters and performers may be difficult to enforce. However, composers and music publishers may participate in licenses negotiated by ASCAP, a non-profit organization which maintains "master" agreements with nearly all organizations that profit from music performance (e.g. broadcast media, concert halls, etc.). Similarly, the rise of university licensing offices following the *Bayh–Dole Act* seems to have increased the commercialization rate of technologies developed within universities (Mowery, 2001). Though universities have always produced ideas with potential commercial application, the establishment of a formal process for technology transfer increased the ability of universities to protect their inventions while allowing firms to evaluate and experiment with potential commercial applications.

Overall, while individual established firms may engage in reputation-based ideas trading, the extent of the market may depend on third-parties and institutions outside the their direct control. Moreover, reputation serves as an asset reinforcing their competitive advantage by increasing their access to external technologies. However, the maintenance of this reputation requires continued commitment. In 1980s, Johnson and Johnson was drawn into a costly litigation with Amgen over their commercialization partnership for Amgen's blockbuster drug EPO. While this litigation battle may have made sense in the context of the Johnson and Johnson/Amgen relationship, it diminished Johnson and Johnson's reputation as a biotechnology collaboration partner, at least for a few years. From the perspective of an established firm, ineffective management of reputation cedes external innovation opportunities to other downstream competitors.

### 4.4. Greenfield competition

The patterns of commercialization are similarly subtle in the final environment, where incumbent complementary assets are unimportant but start-up innovators can preclude effective imitation. While established firms set the terms for ideas trading when excludability is weak, the power to determine the most effective commercialization strategy lies with the start-up innovator under Greenfield competition. While the potential for returns in the product market are high (since imitation is difficult), this market power will be reflected in increased bargaining power with potential partners. As a result, the *relative* returns to competition over cooperation will depend on factors distinct from the intrinsic value of the technology. In this environment, technology entrepreneurs enjoy freedom to evaluate competition and cooperation options in the absence of the risk of expropriation or the inability to overcome established firm market power.

In this environment, both competition and cooperation strategies may be effective. For example, after Chester Carlson and the Haloid Corporation agreed to commercialize early xerography technology (changing their name to Xerox in the process), the company developed a complete vertical chain to support the technology, from manufacturing to distribution to marketing and servicing. This strategy allowed Xerox to maintain tight control over the development and deployment of subsequent technologies (resulting in close antitrust scrutiny in the 1970s). In contrast, Nintendo's game platform business is based on the widespread licensing of its software development tools to independent game developers. In those platform generations in which Nintendo has established a strong market position, Nintendo has been able to extract tremendous rewards from this system, by encouraging high-quality video game development and encouraging medium-term standardization on the Nintendo platform.

When choosing between cooperation and competition under Greenfield competition, the ability to control the development and evolution of platforms and standards may be decisive. For example, tight control over the technology may allow a technology entrepreneur to ensure compatibility with future generations of the technology; as a result, investments to control the key elements of the value chain may be

worthwhile. On the other hand, when there are few opportunities to leverage the current technology as a platform for future generations, an "open" system of independent incremental innovations may be more effective. More generally, technology entrepreneurs must analyze the opportunities and potential for future hazards associated with cooperation or competition at each stage of the value chain, with the result that the optimal strategy may involve an intermediate level of integration.[10]

Overall, this environment offers a tremendous opportunity for start-up innovators. However, this potential raises the possibility of a first-stage "race" to secure a first-mover position. In other words, both technology entrepreneurs and established firms may engage in Schumpeterian competition "for the market" rather than through traditional tactics "within the market" (Evans and Schmalensee, 2002). The potential to dissipate the value of the rents arising from market leadership offers a final cautionary note about the strategic attractiveness of Greenfield competition.

## 5. Implications for technology entrepreneurs

The commercialization strategy framework suggests that variations in how innovations are introduced across sectors result from differences in firms' commercialization environment. To maximize the returns from a given technological innovation, start-up strategy involves exploiting the specific type of opportunities arising from that environment. This insight holds several implications for the management of high-technology entrepreneurial firms:

### *5.1. Commercialization strategy should reflect the firm's commercialization environment*

For many technology entrepreneurs, the challenge of earning any return on innovation often results in ad hoc strategy development and execution (Bhide, 2000). Firms opportunistically take advantage of potential revenue opportunities as they present themselves, rather than choosing a strategy that focuses resources and attention towards activities most likely to yield the highest long-term return. To best take advantage of an innovation, a start-up innovator should undertake a systematic analysis of the level of excludability and the degree to which key complementary assets are controlled by established firms who could serve as competitive threats. Importantly, given that no intellectual property regime is perfectly secure, the start-up must assess whether the enforcement of intellectual property rights is sufficiently cost-effective to serve as a deterrent to expropriation during negotiations. Further, as Teece (1986) emphasized, strategy choice should be include a complete accounting of the complementary assets required for effective commercialization and the degree to which they are controlled by existing players. While it may be possible to enter a market without investing in all areas, the ability to extract value from innovation ultimately depends on the customer value proposition, rather than the simple offering of the technology by itself. During the Internet boom of the late 1990s, many technology entrepreneurs seem to have underestimated the costs and challenges associated with developing de novo complementary assets (e.g. Webvan's failure was a result in part of their underestimate of how costly it would be to offer a vertically integrated substitute for the supermarket industry value chain). While such investments are a necessary component of a competition strategy, strategy choice depends on evaluating the relative returns to innovation along alternative routes, accounting for the sunk cost of investing in assets along each path.

In the absence of explicit evaluation and strategy choice, technology entrepreneurs often "iterate" towards a position which fits their overall environment. In Gans et al. (in press), we report on the results of a detailed survey of 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. Our results suggest that cooperation is much more likely to be chosen by firms able to acquire intellectual property protection or for whom control over complementary assets was

[10] For example, Segway, the start-up innovator behind a new transportation technology, is outsourcing the manufacturing of key components but maintaining control over final assembly, branding and distribution.

not cost-effective. While these results suggest that the strategy ultimately reflect the environment, our qualitative assessment, based on our data gathering experience, is that many entrepreneurial firms find choosing and executing on strategy choice among the most difficult of their organizational challenges. Specifically, many entrepreneurs recounted the evolution and experimentation that preceded their current strategy, remarking that an ex ante analysis would have allowed them to earn additional returns from their innovations.

### *5.2. The value earned on the market for ideas extends beyond the value of access to specialized complementary assets*

In most cases, the imperfect excludability of technology implies that start-up innovators should be sensitive to subtle facets of the market for ideas. On the one hand, the ability to trust potential collaborators is at the heart of an effective cooperation strategy. The value of a partnership depends on whether a reputation has been established in the past and whether incentives exist to maintain that reputation into the future. When both of these conditions hold for a potential partner, it is likely that expropriation can be avoided, raising the overall returns to innovation. Beyond reputation, brokers, such as venture capitalists, and more formal institutions may increase the operational effectiveness of market for ideas, allowing technology entrepreneurs to be exposed to a wider and more sophisticated population of potential ideas buyers.

When excludability is particularly strong, relationships forged through the market for ideas will impact the longer-term advantage that may be derived from the technology. Often including follow-on product development and the management of uncertain contingencies, relational contracting allows both technology entrepreneurs and more established firms to overcome the hazards of partnership by committing to a longer-term relationship with each other.

### *5.3. The returns to cooperation depend on the timing of collaboration*

For many technologies, investments in complementary assets can proceed in multiple steps. From the earliest development and refinement of new technology, innovators pass through key hurdles and milestones and finally introduce a product to market by developing a manufacturing capability and distribution chain. Cooperative commercialization strategies potentially involves collaboration with downstream partners at any of these stages. Early on, the uncertain value of the technology, potential inability to secure the strongest intellectual property protection, and the availability of alternatives for established firms weakens the bargaining position of the start-up innovator. So long as assets required at these early stages are not controlled by others, the start-up has an option to invest in these to both improve its bargaining position and avoid hazards associated with disagreement over a technology's value in subsequent ideas trading.

However, independent commercialization can go too far. If cooperation waits until the latest stages, innovators will have incurred substantial sunk investment costs, reducing the gains from trade with established firms. The key to an effective cooperation strategy is to initiate cooperation at a point where technological uncertainty is sufficiently low but sunk investment costs have not yet become substantial. Achieving this delicate balance depends on start-up innovators assessing commercialization strategy at each stage, weighing the bargaining advantages arising from continued independence against the cost advantages associated with collaboration. Within the biotechnology industry, this tension about when to cooperate is pervasive, with many firms attempting to increase the range of their independent activities as their experience with multiple drugs grows over time.

### *5.4. The returns to product market entry depend on the pacing of competition*

At the heart of a competition strategy is the ability to delay the timing of when established firms recognize the threat posed by the novel value proposition offered by the technology entrepreneur. If detection is sufficiently early, established firms can respond and adapt the entrepreneur's technology in order to take advantage of their competencies and specific positioning. Strategies such as targeting niche customer segments allow a start-up innovator to delay detection until they are ready to compete head-to-head with incumbents. As pointed by Cusumano and Yoffie (1998), Netscape's strategy of openly challenging

Microsoft's product market leadership was a principal driver of Microsoft's ability to reverse its course of ignoring browser technology and move to compete head-to-head with Netscape. Cusumano and Yoffie recommend "do not moon the giant"; a stealth commercialization strategy achieves this objective.

### *5.5. Investment in innovation should be sensitive to the most attractive commercialization environment*

Our analysis suggests that each commercialization strategy environment holds its own hazards and potential opportunities. For example, even an environment that may be a poor choice for technology investment in most circumstances—such as where innovation is non-excludable and key complementary assets are held by established firms—may be quite lucrative under the right conditions. To the extent that established players are investing in their reputations as ideas buyers, the returns to technology entrepreneurs may be substantial, precisely because that reputation involves ceding rents to start-up innovators. Conversely, when the rents from commercialization tends to be the most favorable—Greenfield competition, the market may be subject to rent dissipation as multiple firms race for a dominant position. Overall, entrepreneurs can choose to direct scarce resource into those technology projects which have the highest chance of yielding innovations in a commercialization environment favorable for the firm's long-term advantage.

Our analysis suggests that firms pay attention to the *interaction of intellectual property and complementary assets*, and the impact of that interaction on more subtle aspects of the business environment. This focus on the commercialization environment informs strategy choice both after technologies have been developed and during project selection when innovative investments are initially being contemplated.

## 6. Conclusion

This paper provides a framework for evaluating start-up commercialization strategy and patterns of competitive interaction between start-up and established firms. Our primary argument has been that key aspects of the commercialization environment drive technology entrepreneurs to choose between cooperative or competitive strategies, and these choices impact the evolution of market structure. When intellectual property protection is strong and important specialized complementary assets are held by incumbent firms, start-up firms generate more innovative rents if they pursue cooperative options with incumbent firms rather than competing directly in product markets. As a result, changes in technological leadership need not result in changes in market leadership. In contrast, when weak intellectual property for innovation exists alongside low barriers to entry, competitive commercialization strategies are more likely. A clear understanding of this environment leads start-up innovators to exploit the "blind spots" of incumbent players. As a result, the failure to recognize threats to market leadership may often be the result of an active "stealth" strategy on the part of entrepreneurs.

This framework sheds light on several aspects of technology strategy. Consider the role of intellectual property rights. While intellectual property protection provides a valuable asset, it also serves to enhance the creation of markets for ideas. Consequently, it allows for cooperation between start-ups and incumbents who might otherwise view innovation purely as a competitive threat. This serves as an opportunity for incumbents to tap the high-powered incentives, creativity and flexibility traditionally associated with small firms. Relative to a market with a high rate of creative destruction (and so few stable rents), this pattern may allow for an overall increase in resources to be devoted to innovation, with gains for established firms and entrepreneurs.

Further, our analysis suggests that the strategic management of innovation should focus less on whether a particular technology is 'radical' in an engineering sense (i.e. displacing existing technologies) and more on whether that technology is 'radical' in an organizational or market sense. If entrepreneurial innovation undermines existing incumbent assets, the returns to cooperation are reduced in favor of competition. In contrast, the fact that a technology is disruptive should not be decisive if key complementary assets remain with established players. In this situation, an incumbent's competitive position may often be enhanced rather than threatened by start-up innovation.

This framework also provides insight for public policy. For example, while debates over intellectual property protection concentrate on the costs

associated with temporary monopoly power, our analysis reinforces an emerging perspective that one of the critical roles played by the patent system is to enhance the efficiency of the market for ideas. Stronger intellectual property protection allows innovators to earn greater rents by improving their contracting options and not simply by granting them market power. That is, such policies alleviates problems of disclosure allowing start-up firms to consider contracting options without fear of expropriation.

This effect impacts subsequent competition since start-up innovators are likely to reinforce rather than undermine established market power. While this raises important antitrust concerns about the effects of licensing on competitive entry, an analysis of the appropriate tradeoff for public policy is subtle. A start-up innovator with weak intellectual property protection is likely a weak competitor, dampening the innovation incentives of entrepreneurs. At the same time, the precise structure and functioning of the market for ideas will depend on subtle factors, including the incentives for reputation-building on the part of established firms, the existence of institutions and brokers that facilitate trade, and the ability to secure exclusive agreements while simultaneously threatening to cooperate with third-parties (as in Anton and Yao, 1994). An integrated analysis of the interplay among these factors is important for effective policymaking in this area, but this is something we leave for future work.

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