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INTRODUCTION: ENTREPRENEURSHIP, INNOVATION, AND PLATFORMS

During the last three decades, innovation and entrepreneurship have been among the most dynamic topics within the field of strategic management. Sparked by the insights of Joseph Schumpeter, strategy scholars have devoted increasing effort to understanding innovation as an engine for firm performance, to understanding the drivers and success factors associated with entrepreneurship, and to understanding the role of each in value creation, value capture, and economic welfare.

The central puzzle of Schumpeterian competition compares the advantages enjoyed by entrepreneurs and those inherent to incumbency. In both formal game theory and natural language theories, interaction between incumbents and entrants has become increasingly rooted in the dynamics of R&D, the incentives for and competence to innovate, and a potential entrant's post-innovation choice between competing and collaborating with an incumbent. Formal models have built on Teece's (1986) insights about complementary assets to examine the circumstances under which an entrant will commercialize its innovation via collaboration with an incumbent (Gans & Stern, 2003). Studies of industry evolution increasingly turn on the competition between extant and entering cohorts of firms endowed with different technologies or innovative propensities (Adner & Snow, 2010). In sum, entrepreneurial innovation has become the dominant motivation for strategy's most enduring question: when and how does market entry dissipate incumbent profits?

The challenges and implications of innovation for incumbents are also core research topics in strategic management. Some of the pioneering work in this area examined how incumbents innovate, evolve, and change over time (Nelson & Winter, 1982), why incumbents sometimes fail in the face of certain types of innovation (Henderson & Clark, 1990), how innovations and innovation capabilities correlate with competitive advantage (e.g., Henderson & Cockburn, 1994; Kogut & Zander, 1992), and under what conditions incumbents are able to protect themselves from innovations from outside their industry (Teece, 1986, 1998; Tripsas, 1997). Related research in corporate strategy has examined the relationships between innovation and diversification (Silverman, 1999), among innovation, acquisitions, and alliances (Sampson, 2005), and between innovation and the vertical boundaries of the firm (Pisano, 1990). Ideas about the value of innovation for competitive advantage have been incorporated into theoretical research as well, especially in the resource-based view of the firm and also in perspectives based in the disciplines, including work based in economic sociology examining the interaction between network position, innovation, and competitive advantage (e.g., Powell, Koput, & Smith-Doerr, 1996). The insights and approaches of these earlier inquiries have yielded a variety of research lines that continue to be among the most vibrant in strategic management. For example, burgeoning work examines the roles of mental models and cognition in driving innovation and firm performance (Kaplan & Vakili, 2015; Tripsas & Gavetti, 2000), the role of the market for ideas in shaping the boundaries of the firm (Arora, Fosfuri, & Gambardella, 2001; Gans & Stern, 2010), and the role of innovation for value creation and value capture in firms (Lieberman, Garcia-Castro, & Balasubramanian, 2017). Questions about how incumbents can best manage innovation were at the forefront of early inquiry and remain among the central questions today (Nelson, 1962, 1991).

As digital technologies pervaded the economy from the late 1990s through today, increased attention has been paid to network effects (Parker & Van Alstyne, 2005), ecosystems (Adner, 2017; Adner & Kapoor, 2010), and platform strategies (Gawer & Cusumano, 2002, 2014; Hagiu & Wright, 2015). Platforms matter not only because some of the most powerful and innovative digital firms such as Google, Amazon, Apple, and Facebook all develop technological platforms and operate platform business models. These firms are only the most visible elements of a profound economic movement, as platform-owning firms constitute an increasingly larger part of the economy, totaling a market capitalization of platform firms estimated to be greater than $4 trillion (Accenture, 2016; Evans & Gawer, 2016). Platforms-based innovation ecosystems may well be the new dominant organizational form of an increasingly digital economy. For strategy researchers, the academic literature on platforms has gathered momentum, building on the insights of economic Nobel prize winner Jean Tirole (Rochet & Tirole, 2003), as well as earlier work by Bresnahan and Greenstein (1999). Some of the most exciting directions of strategy research in this area are seeking to complement a purely economic understanding of platforms as multi-sided markets with an appreciation of innovation dynamics and organizational dynamics of platform-based ecosystems (Baldwin & Woodard, 2009; Boudreau, 2010; Gawer, 2014).

This volume extends these three branches of strategic management literature in distinctive and mutually reinforcing ways.

Entrepreneurship and Entrant–Incumbent Dynamics

The first module of this volume focuses on entrepreneurship and entrant–incumbent dynamics. Three studies explore competition between entrant and incumbent, both integrating insights from the extant literature and extending these insights in new, often counter-intuitive directions.

In "Negotiating for the Market," Joshua S. Gans considers a subtle but central question at the intersection between strategy, innovation and entrepreneurship: Beyond the static gains from trade that arise when an entrant develops an innovation that can potentially displace an incumbent technology, how does the possibility for the entrant and incumbent to further their dynamic capabilities facilitate or hinder the prospect of cooperation versus competition? A significant theoretical and empirical literature considers the static gains (and costs) from cooperation versus commercialization. At the same time, there is a more informal argument that entrants who license or sell out at an early stage may overlook the possibility of developing dynamic capabilities that would actually be more valuable than the agreement they achieve with a current incumbent. Although this intuition is often invoked in both academic research and practice, there is little careful examination of when and why such a condition might hold (or be meaningfully important). Given this context, Gans's study is the first to consider start-up commercialization strategy relying upon a formal model of dynamic innovation. The chapter is not simply a model-building exercise, but derives the logic for a new and important insight: the potential for dynamic capabilities can, indeed, undermine the case for cooperation. The case under which this occurs is not simply that the innovative entrant would gain valuable dynamic capabilities under competition, but that this effect is larger than the capabilities that would be earned through some form of integration.

Gans's model is simple and elegant: each period features an innovation "leader" who can be the incumbent or entrant, the technology developed completely displaces the current technology, and both incumbent and entrant have some advantage (over a random new entrant) in becoming the innovation leader the next period. Importantly, the relative size of that advantage for each respective actor depends endogenously on whether, when the entrant is the innovation leader, the entrant and current incumbent choose to cooperate or not. Key findings of the chapter are that: (a) when incumbent and entrant capabilities can be combined, the entrant will be acquired; (b) when innovators can maintain innovation leadership even if they are not producers, the entrant will license to the incumbent; and (c) when innovative leadership requires production and there are diminishing returns to integration, the entrant will compete with and displace the incumbent.

Innovating entrants typically require external financing to fund their early endeavors. Ramana Nanda and Matthew Rhodes-Kropf's chapter, "Innovation Policies," focuses on a central problem in entrepreneurship: what types of projects will be funded, and how do the institutions that surround funding influence the realized value from entrepreneurial investment? The authors take a creative and novel approach for attacking this problem by exploring the idea that a funder might have to choose and commit to an "innovation policy" regarding failure-tolerance prior to selecting an investment. Whereas an uncommitted investor is free to stop projects after an experiment yields information indicating that the project is NPV-negative, a failure-tolerant investor will commit to fund projects even if an intermediate experiment generates "bad" news. This chapter explores the surprising implications of this commitment for the type of projects that are funded. Specifically, investors who are failure-tolerant must be compensated for their tolerance in the form of more of the upside to projects that are ultimately successful (i.e., in exchange for "fronting" additional money to the entrepreneur independent of outcome, they must be rewarded with a higher fraction of the value when success occurs). This commitment generates a match between failure-tolerant investors and projects that involve less value from experimentation; in contrast, uncommitted investors are willing to fund "high upside" projects but only if they can choose whether to continue based on the value of an informative experiment.

The authors draw out the inevitable consequences of this trade-off: commitment-oriented corporations may end up only funding incremental projects (the value of the upside is low), venture capitalists will be ruthless in shutting down firms after negative information (but will ultimately end up funding more "breakthrough" projects as part of their portfolios), and some projects will ultimately require a funder (such as a government or university endowment) who is willing to commit and also does not need to maximize NPV for its portfolio. A more exploratory section considers the impact of competition among investors for deals in the context of a search model, and derives conditions under which the only funders who exist in equilibrium are high-commitment, low-risk funders.

One of the central issues in the study of entrant–incumbent dynamics regards the competition among firms engaged in technology-based entry. In their chapter, "Nuanced Role of Relevant Prior Experience: Sales Takeoff of Disruptive Products and Product Innovation with Disrupted Technology in Industrial Robotics," Raja Roy and Mazhar Islam focus on an industry that experiences a dramatic change in technology – the shift from mechanical control technology to computer numerical control (CNC) technology in industrial robotics. The authors distinguish between two distinct sets of entrants, those with and without experience in the disrupted technology, and two important time periods, the time before and after the sales takeoff for CNC-based robots. They develop sharp predictions about the relative innovative success of these two sets of entrants in each of the two time periods. Notably, whereas the two sets of firms will be equally adept at producing CNC robots before the sales takeoff, after the takeoff the firms with prior-generation experience will outperform those without such experience.

Empirically, Roy and Islam identify the extent to which nearly 300 firms entering the industrial robotics industry between 1978 and 1983 have experience with the old (disrupted) technology of mechanically controlled robots, relative to their experience with the new (disrupting) technology of CNC robots. Based on a heroic data-gathering effort that involves constructing a dataset from myriad sources, the authors investigate how experience with the disrupted technology is related to success after entry. They find that, indeed, those firms that had higher levels of experience with the disrupted technology prior to sales takeoff have greater success in the period of time after sales take off. Their results have implications for theories of disruptive industry change and for understanding the history of the industrial robotics industry. They also help to clarify debate over the value of experience (which is generally deemed useful) in technological regimes that appear to face obsolescence (which is often deemed harmful).

The three studies in this part thus highlight strategic interactions involving entrant firms at three different interfaces: with financiers, with established incumbent firms, and with other recent entrants. These studies jointly extend our understanding of the competitive dynamics underlying entrepreneurial innovation.

Management of Innovation in Large Firms

The second module of this volume includes three studies that extend our understanding of innovation and technology adoption within large incumbent firms.

Maya Cara, Julian Birkinshaw, and Suzanne Heywood contribute to the long-standing debate regarding complexity and innovation. Scholars are divided on whether organizational complexity is positively or negatively associated with technological innovation by that organization, and prior empirical research is inconclusive on this point. In their chapter, "Structural versus Experienced Complexity: A New Perspective on the Relationship between Organizational Complexity and Innovation," the authors propose an alternative perspective for disaggregating organizational complexity into aspects that favor innovation and aspects that do not, in some ways paralleling the literature on the slack–innovation relationship. In contrast to research that examines organizational complexity at the organizational level, Cara et al. focus their attention on the level of complexity faced by individual managers on a day-to-day basis. Specifically, the authors draw a distinction between *experienced complexity*, "the extent to which the organizational environment makes it challenging for decision-makers to do their jobs effectively," (Cara et al., 2017, p. 117) and *structural complexity*, "the elements of the organization, such as the number of reporting lines or integrating mechanisms" (Cara et al., 2017, p. 117).

Drawing from research on rugged landscapes (Levinthal, 1997), the authors hypothesize that factors associated with structural complexity will be positively associated with firm innovation output. In contrast, elements associated with the novel construct of experienced complexity – notably, the perception of unclear accountabilities and of inefficient processes – will be negatively associated with a firm's innovation output. They find evidence consistent with these hypotheses based on the innovation and complexity constructs developed in their large firm survey. By focusing on the complexity experienced by individuals in large organizations, Cara et al. shift attention to the complexity–innovation relationship toward its micro-foundations and invite future work that builds on this basis for understanding innovation in large firms.

Of course, the organizational structures that affect innovation and adoption need not be formal. Informal networks also matter. In her chapter, "Network Stability, Network Externalities, and Technology Adoption," Catherine Tucker addresses an important yet subtle question: When potential network-technology adopters face increased uncertainty about whom they might interact with, how does that affect their adoption of the technology? From a theoretical perspective, a long (and somewhat inconclusive) literature has yielded two conflicting conclusions. On one hand, uncertainty about potential network partners might enhance adoption incentives since uncertainty induces a scope economy across the potential network. On the other hand, uncertainty reduces the value of any particular connection, and so might reduce adoption incentives. To address this question, an empirical approach is required. Tucker tackles this question by exploiting two "natural experiments" that occurred as a videoconferencing technology was adopted at the firm level by a global financial company, but where adoption decisions by individual employees was voluntary.

As in her now-classic *Management Science* chapter (Tucker, 2008), Tucker exploits the fact that the videoconferencing technology also had a "standalone" benefit as a television which led to selective adoption independent of network benefits by those that wanted to watch particular one-off sporting events (e.g., World Cup, Rugby tournament, etc.). In this chapter, she also introduces a second shock – the dislocation of employees from the firm's New York office in the wake of the September 11 attacks (employees were physically moved and somewhat re-organized after the attacks). This combination allows her to evaluate how the adoption behavior of New York employees differed both relative to other offices and pre- versus post-attacks. Her main emphasized result is that, after the attacks, New York employees were much more sensitive to the people they had the "potential" to interact with rather than those to whom they would immediately be connected after their own adoption. At face value, the size of the network effect nearly doubles for those employees facing a more uncertain communication pattern.

Whereas the above two studies focus on mid-level employees, the third chapter focuses on challenges facing top management. In their chapter "Platforms, Open/User Innovation, and Ecosystems: A Strategic Leadership Perspective," Elizabeth J. Altman and Michael L. Tushman focus on the specific managerial and organizational challenges that firms and their senior teams face when they transition from traditionally closed ways of conducting business to externally focused platform, ecosystem, or open innovation strategies. The phenomena covered by the various streams of the strategy literature on platforms, ecosystems, and open innovation are partially overlapping, yet the often disparate streams of literature have not yet coalesced, nor have they offered a clear view of the distinctions between these concepts and of the extent to which they overlap. Further, while the existing literature focuses mostly on strategic, economic, and management trade-offs of platform, open/user innovation, and ecosystem strategies, there is scant work focusing on implications for firms' leaders.

Altman and Tushman's chapter contributes first by summarizing the main insights of these various streams of literature and by offering a clear comparison between the structures of platforms, ecosystems, and open/user innovation. The authors then turn to the important yet under-researched question of how senior management in mature organizations can successfully face the organizational and managerial challenges posed by transitions to these externally facing strategies. Altman and Tushman use the lens of institutional theory to highlight the cognitive and normative underpinnings of the new externally facing, community- or ecosystem-building strategies. They identify not merely different firms' behaviors, but also the different assumptions and beliefs that underpin the shift from traditionally closed business conduct to the more externally facing platform and ecosystem strategies. The transition from closed to more open strategies is construed as a shift in institutional logics, one that gets instantiated through practices such as (1) increasing external focus, (2) moving to greater openness, (3) focusing on enabling interactions, and (4) adopting interaction-centric metrics. By selecting insights from the strategic leadership literature, the authors identify a number of challenges that senior teams are likely to experience in the context of this transition. They suggest that executive orientation and experiences, especially for senior managers who have operated in either secretive environments or highly competitive technology industry, may hinder them and their organization to adapt to the new behaviors required by the new strategies. They also suggest that the complex and sometimes conflicting nature of decisions associated with the new strategies, as well as finding new metrics and their consequences on executive compensation, can all be problematic for senior management teams.

By focusing on complexity, networks, and top management teams, the three studies in this part span issues central to research on strategy and innovation and highlight decision-making at multiple levels of the organization. Together, the studies provide insights into the challenges of incumbency and innovation, by looking inside the firm, across the firm's internal network, and throughout the firm's ecosystem.

Platform-Based Competition

The third module of this volume focuses on platform-based competition. Four studies explore this subject, with two focusing on strategies of the platform provider, one focusing on the impact of a platform on firms that interact with it, and one focusing on extension of the platform literature to an industry that is rarely seen as a platform-based industry: biotechnology.

David J. Teece's chapter, "Dynamic Capabilities and (Digital) Platform Lifecycles," develops insights into the phenomenon of platforms, drawing on the strategic management theory of dynamic capabilities. Platforms are particularly relevant in the digital economy, Teece suggests, because, on one hand, in this context firms "see their role less in industries and more in business ecosystems (which are made up of organizations and customers working together to create and sustain markets and products)," and, on the other hand, "the coevolution of such ecosystems is typically reliant on the technological leadership of one or two firms that provide a platform around which other system members, providing inputs and complementary goods, align their investments and strategies" (Teece, 2017, p. 212) The chapter extends Moore's (1993) characterization of ecosystem life cycles to identify distinct phases in what Teece calls a "platform lifecycle." This life cycle has four phases: birth, expansion, leadership, and self-renewal. Teece then identifies how various categories of dynamic capabilities are particularly relevant during each phase of the platform life cycle.

Theoretically, in addition to the useful link between dynamic capabilities and platforms, the chapter advances our understanding of platforms by placing the concept of platform within an evolutionary perspective. Historically, within innovation studies and the technology strategy literature, the related concepts of product life cycle and industry life cycle have proven useful to explore how systematic changes in product or industry characteristics spark variation in environmental technological and economic conditions and also shape strategic opportunities. The corresponding line of research has stimulated a rich vein of empirical as well as conceptual studies, and allowed scholars to better understand the interaction between design changes, firms' behavioral changes, and the evolution of various contextual parameters. In this context, Teece's insight to apply a life-cycle lens to platforms is particularly judicious. Platforms, which are sometimes conceived as product technologies and sometimes conceived as an aggregate of firms, are an intriguing and somewhat natural candidate to benefit from a life-cycle lens. The chapter therefore opens what we believe are fruitful avenues for further development in the platform literature.

In his chapter "Platform Boundary Choices: 'Opening-Up' while Still Coordinating and Orchestrating," Kevin J. Boudreau considers the important but overlooked question of platform boundaries. Within the economics and management literature, most existing models of platforms assume that (1) platform boundaries are given, and (2) that boundaries of the platform are isomorphic with the scope of the platform-owning firm. Boudreau introduces a distinction between the boundaries of the platform (technology) and boundaries of the platform owner (firm), and then extends classic economic theories of firm boundaries to generate predictions for the boundaries of platform-based organizations. In particular, Boudreau examines the extent to which narrowing or widening platform boundaries affects (1) investment incentives for both platform owner and complementary parties; (2) internalization of coordination problems; and (3) consolidation of control over critical assets.

Employing rich exposition of historical descriptions of several platforms, Boudreau finds significant cross-sectional variation and regular changes over time in boundary choices, indicating that platform boundaries are neither predetermined by industry conditions nor necessarily identical to the platform owner's boundaries. Further insights are broadly consistent with theoretical predictions. Although the shifting of boundaries *per se* does not seem to significantly alter suppliers' incentives to participate or to invest, the addition of mechanisms that protect the rights of outside suppliers significantly increases these suppliers' willingness to participate. Boudreau also finds that in order to solve coordination problems, the platform-owning firm tends to change not only its own scope, but also the platform's technological boundaries. Finally, he finds that while opening-up might connote disintegration and narrowing platforms, in fact opening up was often coupled with efforts to integrate farther into critical assets that acted as control points in the system. Despite opening up, these platform owners thus retained power to control and orchestrate independent suppliers through contracting, price-setting and rule-making in technical frameworks.

Overall, the examples in this chapter indicate that the fundamental trade-off as portrayed in previous literature – framed as a trade-off between openness-versus-control and coordination – is not confirmed by the evidence. Rather, "most successful open platforms were those that carefully chose boundaries to reconcile the interest of opening-up to harness contributions of outside suppliers with the interest of simultaneously maintaining coordination (in the form of orchestration, sponsorship, leadership, regulation) of activity in their ecosystems or sub-economies" (Boudreau, 2017, p. 284). The case studies and theoretical arguments emphasize therefore the possibility (and suggest to some extent the strategic superiority) of implementing boundaries that achieve both openness-and-control, rather than openness-versus-control.

Whereas the above two chapters focus on strategy for a platform owner, platforms also yield rich implications for competition among other firms in the ecosystem. In "Amazon Warrior: How a Platform Can Restructure Industry Power and Ecology," Henrich R. Greve and Seo Yeon Song address an important question regarding platform-based competition: How do third-party consumer reviews influence the sales of products, and how does this differ for products of dominant incumbent producers versus fringe producers or entrants? The authors propose that, by allowing free dissemination of consumer evaluations, information-sharing platforms allow smaller producers to overcome traditional scale-based marketing disadvantages, thus encouraging sales of fringe producers' products more extensively than those of dominant producers. The authors also distinguish between *discovery platforms* such as Twitter, which enhance exposure to new products, and *evaluation platforms* such as Amazon reviews, which provide information for those already interested in a particular product. The authors then propose that these different types of platforms offer different types of benefits to small producers.

In order to investigate their hypotheses, the authors marshal a substantial amount of data on book sales, the Amazon ratings of each book, and their associated Twitter mentions. They find empirical results that are largely consistent with predictions. There has been substantial prior work on online platforms' ability to reduce search costs and thus generate a "long tail" of sales, which is consistent with this chapter. Yet whereas the bulk of prior research has focused on the ability to search an online retailer's inventory, the novelty of this chapter is its focus on the role of information-providing platforms to influence this process. Building on their theory and findings, the authors speculate about the way in which industry structure and competition may be altered in platform-mediated industries. In particular, the authors suggest that scale advantages may be reduced in industries like book publishing, in which economies of scale had, historically, been important in marketing, advertising, and promotion.

The burgeoning theory on platforms has focused almost exclusively on information and communication technologies (ICT). Joel West's chapter, "Open Source Platforms beyond Software: From ICT to Biotechnology," examines the degree to which platform theory is applicable beyond ICT. It presents an exploratory field study of communities organized around the idea of "open source biology." Interviewees explicitly refer to these collaborations as platforms and acknowledge influence of the ICT open-source model. West first distinguishes between the general attributes of ICT platforms and those of open-source software (OSS) platforms, noting key OSS attributes such as non-exclusive intellectual property, community governance and production models, and modularity. West moves then to characterize the phenomenon of biotechnology platforms, briefly summarizing the evolution of biotech "breakthroughs" and situating them within enduring tensions between "the norms of open science" and "the proprietary goals of strong intellectual property protection."

The chapter's main results, drawn from the analysis of interview data, comprise a description of three types of open-source collaboration within biotechnology – IP commons; Hackerspace; and Crowdsourced patient data–each of which is mapped into the "attributes" of platforms. West finds that these biotech platform models are associated with various subsets of partially overlapping ICT platform attributes. The chapter suggests that the field of biotech has adopted and partially adapted the open-source concept for biomedical products, and that this has been facilitated in part by trends such as the digitalization of biotechnology research processes combined with some participants' explicit desire to emulate the open-source software movement's embrace of open sharing and re-use of knowledge. The chapter also identifies the technical, legal and institutional limits within the biology field which make the pure adoption of open-source software mechanisms impossible or impractical. It concludes by discussing the similarities and difference between open ICT platforms and biology platforms, and suggests implications for platform theory.

West thus raises intriguing questions about the meaning of platforms once we extract them from a pure ICT setting. Of particular note, his chapter indicates that greater attention to the specifics of the discovery and development process is needed to predict the kinds of platform dynamics that may or may not be present in varied empirical settings. The degree of distribution of skills should also matter to facilitate the growth and development of platforms, as well as the extent to which the underlying architectures of the platform technology allows a decoupling through modular interfaces, which allow some parts of the systemic products to be "proprietary" and others to be "open."

In sum, by analyzing platforms from the varied perspectives of platform-owner, platform user, and community member, the four studies in this part identify key strategic issues concerning organizational boundaries, competition, and complementarity in platform-based activity. The studies provide cumulative insights into the viability of platform strategies separate from the underlying technology and both within and outside the traditional digital setting.

CONCLUSION

We believe that the studies in this volume can provide insights and direction to encourage the next wave of research on entrepreneurship, innovation, and platforms. We hope that you will agree that, collectively, they inspire further exploration into these core topics of strategic management.

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PART I
ENTREPRENEURSHIP AND ENTRANT–INCUMBENT DYNAMICS

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NEGOTIATING FOR THE MARKET

Joshua S. Gans

ABSTRACT

In a dynamic environment where underlying competition is "for the market," this chapter examines what happens when entrants and incumbents can instead negotiate for the market. For instance, this might arise when an entrant innovator can choose to license to or be acquired by an incumbent firm (i.e., engage in cooperative commercialization). It is demonstrated that, depending upon the level of firms' potential dynamic capabilities, there may or may not be gains to trade between incumbents and entrants in a cumulative innovation environment; that is, entrants may not be adequately compensated for losses in future innovative potential. This stands in contrast to static analyses that overwhelmingly identify positive gains to trade from such cooperation.

Keywords: Innovation; incumbency; dynamic capabilities; licensing; mergers; commercialization

One of the most important insights in strategy is that factors that diminish competition *in* a market (e.g., patent protection) can themselves intensify competition *for* the market. Of course, it is well known that this trade-off depends on whether those policies themselves generate intertemporal persistence of present market power (Scotchmer, 2004). For instance, broad patents can raise

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barriers to innovative entry and so allow current incumbents to persist. Critically, even where such persistence is not enabled by policy, competition for a market is not inevitable when incumbents and entrants can reach agreements that subvert that outcome (Gans & Stern, 2003; Salant, 1984); that is, when they can *negotiate* for the market.

Beginning with Teece (1987), scholars have asked what factors drive whether a start-up firm chooses to take a product directly to market (broadly termed *competitive commercialization*) or instead to engage in transactions whereby established firms bring those products to final consumers (broadly termed *cooperative commercialization*). Examples of the latter include licensing, alliances, or acquisition; that is, start-up firms become sellers in markets for ideas rather than product markets per se (Gans & Stern, 2003). Overall patterns of commercialization choices can be crucial in determining whether industries follow a Schumpeterian "creative destruction" path where changing technological leadership is associated with changing market leadership or a cooperative path where the two roles are divorced from one another.

To understand these choices, several theoretical drivers have been hypothesized that could lead to a choice of cooperation as opposed to competitive commercialization. First, Teece (1987) emphasized the need to avoid *duplicating complementary assets* (e.g., manufacturing, distribution, marketing, regulatory expertise) held by established firms. Second, Gans and Stern (2000) emphasized the potential for cooperative deals to allow incumbents and start-ups to avoid direct competition and *preserve monopoly rents*.

By either avoiding duplicating complementary assets held by incumbent firms and/or preserving monopoly rents, joint surplus is higher for start-ups and for at least one incumbent from cooperative rather than competitive commercialization. Indeed, because these benefits should be realized whenever start-up or incumbent dealings can take place in a frictionless manner, observations of competitive commercialization are a puzzle. That puzzle has caused strategic management researchers to look to potential frictions to explain competitive commercialization. One set of frictions comes under the general classification of *transactions costs*. This would include the costs associated with brokering deals and also overcoming negotiation problems due to asymmetric information (Gans & Stern, 2003). However, these costs may arise even when entering product markets (Grossman & Hart, 1986), and, when considering implications in a nuanced way, would delay cooperative commercialization rather than drive competitive commercialization per se (Alian, Henry, & Kyle, 2016; Gans, Hsu, & Stern, 2008).

For these reasons, rather than focus on transaction costs, attention has been drawn to issues of the transmission of information that is often required to make cooperative commercialization attractive. For instance, Arrow (1962) identified disclosures that must be undertaken to sell ideas as a reason to avoid such trade. Gans and Stern (2000) demonstrated that this could lead to secrecy and, by implication, competitive commercialization, noting the caveat that, in some situations, competitive threats could overcome disclosure problems (Anton & Yao, 1994) or facilitate the transfer of know-how (Arora, 1995). Gans, Hsu, and Stern (2002) demonstrated that, because of this, stronger patent protection could have a key role in facilitating cooperative commercialization and confirmed this empirically (see also Arora & Ceccagnoli, 2006). Gans et al. (2008) then highlighted further evidence for frictions related to information transmission by looking at the timing of licensing transactions. Finally, Hsu (2006) found that venture capitalists with strong reputations and networks would facilitate a choice of cooperation over competition again as a means of mitigating potential barriers in information flows that might otherwise prove a barrier to such deals. Dushnitsky and Shaver (2009) highlighted similar forces with regard to corporate venture capital and the importance of disclosure issues when intellectual property protection is weak.

Thus, there has been significant progress made in understanding what factors may increase the value of cooperative commercialization relative to competitive outcomes as well as the frictions (and strategies to overcome them) that might cause cooperation not to be realized. However, as carefully documented by Arora and Gambardella (2009), there are many industries where licensing or other forms of cooperative commercialization are not favored over more competitive paths. In addition, there are many prominent examples of firms that, despite being targeted, chose competition ultimately to lead the market. They include, among others, Apple, Google, Genzyme, Intuit, and Facebook. Importantly, the current theoretical progress, as well as empirical analyses built on it, has focused on essentially *static* drivers of commercialization choice. This stands in contrast to informal discussions that emphasize dynamic considerations; specifically, that start-up innovators may be reluctant to relinquish control of their inventions lest it preclude them from future innovation or result in "selling their birthright" to downstream innovative rents.[1] In the language of strategic management, there is concern that cooperative commercialization may prevent start-up firms from developing key dynamic capabilities.

Given this, the contribution of this chapter is to bring together the literature on dynamic capabilities (specifically Teece, Pisano, & Shuen, 1997) with the literature on the choice of start-up commercialization strategy. In the process, a new potential driver of start-up commercialization choice is developed that emphasizes the relative dynamic capabilities that start-ups and incumbents possess in becoming future innovative leaders in an industry and how these relate to their roles and experience in commercialization itself. To do this, a model of innovation where innovation is cumulative is analyzed. That model examines dynamic capabilities as derived from commercialization experience and considers how this affects the negotiations between start-ups and incumbents regarding whether they cooperate or compete.

With this framework, I find some important and subtle dynamic effects that significantly qualify the intuition of static models of innovation. First, the returns to licensing are driven by the value of incumbent technological leadership. In each period, there is an innovation leader who may be the incumbent or an entrant and their innovation displaces the current technology. Both types of firms have an advantage by virtue of their experience in leading innovation following that. The key insight is that the size of that advantage is driven by experience but experience is determined endogenously by whether the parties choose to cooperate or not. This, in turn, drives the gains to trade from licensing.

Second, the gains from trade from licensing may not always be positive. To understand this, consider the recent acquisition of Instagram by Facebook. Instagram had pioneered mobile photo sharing and the social aspects of this looked like they might infringe on Facebook's space. By acquiring Instagram, Facebook denied it the experience of independently building social capabilities although it did permit it to continue to innovate on mobile visual sharing. However, what if Instagram could have benefited from being able to pursue those capabilities themselves independently of Facebook? If that potential was sufficiently great, there would be no gains to trade from licensing or being acquired by Facebook and a deal would not have been done. In summary, depending upon the relative dynamic capabilities, both firms may find this mutually preferable to cooperative commercialization. This captures some of the motivating informal intuitions that dynamic capabilities may favor in order to continue competition, but it also highlights some subtleties in how such capabilities generate this outcome.

The chapter proceeds as follows: in the first section, I outline key modeling choices that I draw upon to build a dynamic environment; in the second section, the basic model is introduced; and in the third section, the baseline results regarding negotiating for the market are presented. The model characterizes the gains from trade from licensing and/or acquisition purely in terms of dynamic factors. It is demonstrated that these modes have distinct dynamic differences; in particular, acquisition may lead to a loss of future innovative rents in favor of potential future entrants. The fourth section considers a number of extensions, including static product market competition and an endogenous rate of innovation. In the fifth section, alternative contracting possibilities that may impact on observed commercialization choices are considered. A final section concludes the discussion.

KEY MODELING CHOICES

Due to the complexities that arise when adding dynamic considerations into models of commercialization, it is useful to outline in detail the key modeling choices made in this chapter. The first is to consider what is meant by a *dynamic capability*. As is well known, the concept of a dynamic capability is one that is relatively fluid within the strategy literature. A firm's capabilities are usually defined in terms of their ability to deliver products of a certain quality and at a certain cost. This ability then defines the position within a competitive marketplace. Dynamic capabilities are a step beyond this and refer to a firm's ability to transition in a changing environment. For instance, Teece et al. (1997) "define dynamic capabilities as the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (p. 516).[2] Moreover, such capabilities are generally considered difficult to contract over and to transfer across firm boundaries.

The focus here on commercialization choices leads us to focus on a *specific* type of dynamic capability highlighted in the strategic management literature: capabilities that are derived from *experience* in an activity that improve the chances of a firm becoming a technology leader. Experience-based capabilities are identified by Eisenhardt and Martin (2000) as being most salient and relevant in industries where technological change is rapid. Eisenhardt and Martin (2000) emphasize that advantages from such learning by doing are not long-lived and must be sustained by continual experiential activities. In this respect, this fits well with the environment that is the focus here whereby start-ups and incumbents face cumulative innovative opportunities with future products replacing current ones in a process of creative destruction.[3] In effect, it builds on a key insight of the dynamic capabilities literature that such capabilities are accumulated rather than acquired, in effect, treating the commercialization process itself as a "strategic factor market" (as per Dierickx & Cool, 1989).

To capture this formally, two activities of relevance are identified that can generate experience relevant to future innovative potential – current innovation and current production (or more broadly complementary commercialization activities to innovation). Experience in *innovation* comes from the effort and management associated with generating new products, while experience in *production* comes from the activities associated with taking a product to market (including manufacturing, distribution, and marketing).[4] Importantly, for start-up firms and incumbents alike, experience in each of these with respect to the current product generation can give those firms advantages in generating future product innovations.[5] However, whether firms gain that experience or not depends on their commercialization choice. Specifically, under cooperative commercialization, start-ups do not gain as much production experience, whereas established firms gain more. The reverse is true under competitive commercialization. As will be demonstrated, both firms take this into account in negotiating the division of the surplus under cooperative commercialization and that, critically, joint surplus may be higher when they do not cooperate and instead compete. This allows us to identify new potential drivers of commercialization strategy.

The second set of modeling choices concern key economic considerations in determining commercialization strategy. Specifically, the model provides for cumulative innovation and allows for the possibility that a patent associated with an innovation can be transferred to incumbents; it then provides a selection process for future innovation leaders that takes explicit account of the dynamic capability considerations discussed above. To achieve a model that captures these elements, the tractable framework of Segal and Whinston (2007) is amended (which itself builds upon Aghion & Howitt, 1992). That framework was used by them to explore entrant innovation in the context of competitive interactions with an incumbent firm. Segal and Whinston (2007) only considered competition and the effect of incumbent antitrust practices on rates of innovation.[6] In addition, they assumed that the same firms would persist in the industry through successive waves of innovation; something I relax here by adding in elements of the leadership model of O'Donoghue, Scotchmer, and Thisse (1998).

Specifically, the model set up here considers an environment where, at any given point in time, there are (effectively) at most two active firms in the industry – an incumbent and an entrant.[7] As in Segal and Whinston (2007), an entrant today may become an incumbent tomorrow and vice versa. Unlike Segal and Whinston (2007), I also allow incumbents to assume an innovation leadership role. When an entrant innovates, if there is no cooperation (i.e., licensing or acquisition), it displaces the incumbent for the next generation of innovation. If there is cooperation, the incumbent is not displaced and preserves its production role.

In the baseline model, designed to focus on dynamic considerations, innovations displace completely and immediately the economic value of previous generation products.[8] In this respect, the underlying structure of the game is one that is termed "Schumpeterian," "greenfield," or "winner-take-all" competition (Gans & Stern, 2003).[9] When there is competition for the market, the outcome will be characterized by successive monopolies, each displacing the predecessor through innovation. When there is negotiation, there are still successive monopolies, but the same firm may persist for longer. Segal and Whinston (2007) did not provide a means of analyzing the persistence of firms as they assumed all firms to persist indefinitely. Here, to take into account dynamic capabilities, a more general setup with potentially short-lived firms as well as long-lived innovators is developed.[10] Consequently, the model here can explore the impact of the commercialization decision on the structure of competition in innovation markets in the future. This complements previous analyses based on static product market impacts alone (Gans & Stern, 2000).

MODEL SETUP

In this section, I describe the basic setup of the model. It is designed to capture the key elements of a choice between competition and cooperation that focuses on the dynamic elements of that decision. The model is similar to a "quality ladder" model of innovation in that innovation is directed at producing the next generation of a product that dominates the market; in effect, the new product replaces the old in a "winner-take-all" manner. This captures the notion that innovating is equivalent to achieving market leadership.

Firms and Innovations

The model involves discrete time and an infinite horizon with the common discount rate for all participants of $\delta \in [0, 1]$. Innovations occur sequentially with each innovation being a new product that yields valuable quality advantages over the previous generation. To keep with the assumption of Schumpeterian competition, it is assumed that, at given point in time, there is a single incumbent-producer (I) of that new product that can extract a constant flow of monopoly rents, Π, until such time as it is displaced by a new innovation.[11] This might arise if the innovator has a patent right that, while long-lived, can, because of other consumer choices for related products or work-arounds, lead to only a certain level of profit even if the patent rights to one or more generations are controlled by the same entity.[12] This is a standard assumption in models of cumulative innovation and creative destruction (Scotchmer, 2004). This assumption allows us to focus purely on dynamic characteristics.

Dynamic Capabilities

A novel feature of the model here is that the set of innovating firms can change from generation to generation. Specifically, I allow for both the possibility that a firm is present in the market during the development of the next generation and the possibility that it is not, following a successful innovation. As noted earlier, for most models of patent races and innovation, displaced incumbents exit the industry; Segal and Whinston (2007), however, argue that a displaced incumbent merely forgoes technological leadership, taking on the role of the entrant.

Here, I nest both of these possibilities. For each product generation, it is assumed that there is only one firm – *the innovation leader* – conducting R&D in the market. Following O'Donoghue et al. (1998), the innovation leader for a product generation is randomly drawn from a pool of firms (infinite in number) and include the current incumbent-producer that could potentially innovate.[13] This structure amounts to assuming that the "know-how" of how to progress toward the next product innovation is acquired by a single firm that can then exploit it by engaging in research toward that next generation product.[14] However, there are distinct reasons why different types of firms might have a greater chance of being selected from that pool; that is, different types of firms are given an advantage in future innovative competition. Those differences rest on differing dynamic capabilities.

Recall that, by dynamic capabilities, I am focusing here on capabilities that enhance a firm's likelihood of becoming an innovator for a future product generation. Relying on the notion of experienced-based dynamic capabilities (as in Eisenhardt & Martin, 2000), there are two sources of experience that are assumed to matter – experience in innovation and in production. The latter includes all of those activities associated with bringing a product to market (that is, complementary commercialization activities). Experience in each of these for the current product generation is assumed to give a firm an advantage in becoming the innovation leader in the next generation. Recall that the innovation leader is formally selected from a large pool of firms in which those without experience have an infinitesimal probability of being selected. This is not the case for active participants in the industry where experience may improve their chances of being selected.

For a previous incumbent-producer (I) that is not an innovation leader, knowledge and experience of the industry may afford it an advantage due to superior knowledge of the market and customers. This is a capability that arises as a result of being a producer. To capture this, I assume that following successful past innovation in the industry, with probability $\sigma_p \in [0, 1]$, the incumbent-producer becomes the innovation leader for the next generation (the subscript p here standing for innovative capabilities generated by virtue of being a *p*roducer). Otherwise, the incumbent (effectively) exits the industry and another firm takes on the role of the entrant.[15]

For an entrant (E) that pursues cooperative commercialization, its future innovative advantage may arise because of its knowledge of the innovative process for this line of products. To capture this, I assume that an entrant that innovates, with probability $\sigma_i \in [0, 1]$ (the subscript i here standing for innovative capabilities generated by virtue of being an *i*nnovator), becomes the innovation leader (again as an incumbent or entrant as the case may be). Otherwise, the entrant exits and potentially is replaced by a new entrant. As noted earlier, this provides a means of parameterizing and modeling an innovator's "birthright" to future innovative rents. It captures its advantage in generating future innovations.

Finally, the previous incumbent-producer might also be an innovation leader. In this case, it combines the knowledge from production and innovation which translates into a probability of $\sigma_{ip} \in [0, 1]$, which it will continue as the innovation leader for the next generation (the subscript ip here standing for capabilities generated by virtue of being both a producer and an innovator). This probability can also arise if an innovating entrant and a non-innovating incumbent were to integrate through an acquisition (rather than licensing).

It is reasonable to assume that $\sigma_{ip} \geq \max\{\sigma_p, \sigma_i\}$, as any resources that allow the firm to combine experiences in a manner that reduces dynamic capabilities

Table 1. Acquiring Dynamic Capabilities.

Experience	Example	Probability of Leadership
Production only	*I* not an innovation leader	$\sigma_p \in [0, 1]$
Innovation only	*E* as innovation leader	$\sigma_i \in [0, 1]$
Production + Innovation	Merger or *I* as innovation leader	$\sigma_{ip} \geq \max\{\sigma_p, \sigma_i\}$

can surely be disposed of freely to ensure that the dynamic capability is at least as strong as it would be based on being a separate producer or innovator. This assumption of *free disposal* is maintained throughout the chapter, although it is useful to note that in some cases, organizations may face other constraints that might violate this assumption (e.g., as documented by Henderson, 1993).

In summary, experience in production or innovation, or both, can give firms an advantage in becoming the next innovation leader (see the summary in Table 1). As will be demonstrated below, a choice of cooperative commercialization can determine which firms are likely to gain experience and hence, which firm is likely to become the next innovation leader. That is, the dynamic capabilities that exist in the industry are endogenous to the choice of commercialization strategy as negotiated between incumbents and entrants.

Commercialization Choices

When a new product is generated by an entrant, the patent holder, *E*, faces a choice. It can enter into production of the product generation (competition) or it can negotiate with the current incumbent-producer (cooperation).[16] Following this, in the next period, uncertainty is resolved as to whether the firm that does not hold patent production rights is selected from the pool of firms to become the next entrant.

If *E* chooses a *competitive* path, *I* loses its monopoly profits, while *E* assumes the incumbent's role and earns Π in each period it remains the incumbent-producer. The previous incumbent then becomes one in the pool of firms from which the next entrant will be selected. *E* also has a chance of becoming the innovation leader but in the incumbent role.

Alternatively, if *E* chooses a *cooperative* path, it negotiates to sell *I* an exclusive license to its innovation.[17] I assume that such negotiations take the Nash bargaining form in which the incumbent and the entrant both have equal bargaining power.[18] If a licensing deal is successfully negotiated, *E* receives a once-off payment, τ, while *I* preserves its incumbent-producer position. In this situation, it is *E* that returns to the pool of firms as a potential future entrant, and *I* has a chance of becoming the innovation leader as an incumbent.

NEGOTIATION OUTCOMES

We are now in a position to consider what happens when firms have the opportunity to negotiate over the terms of a cooperative agreement should an entrant innovate. These negotiations take place in the shadow of potential competition, which here involves the entrant innovator displacing the incumbent and taking its position for that product generation. As will be demonstrated, relative to cooperation, this alters which firm earns the monopoly rents from that innovation as well as which firm acquires production-based capabilities.

Licensing

The first case to consider is where an entrant innovator negotiates to grant an exclusive license to the incumbent. In that contract, the incumbent maintains its role as a producer for that product generation, while the entrant returns to the pool to become a potential innovator toward the next product generation.

In each period, t, the following stage game is played:

1. *Selection*: The innovation leader for the next product generation is selected from the pool of potential innovators.
2. *Production*: The firm that holds the production rights to the current product generation sells the product, earns rents of Π, and acquires a production-based capability.
3. *Innovation*: A new product generation is developed by the innovation leader, which acquires an innovation-based capability.
4. *Negotiations*: If the innovation leader selected was the incumbent, the stage game ends. If the innovation leader selected was an entrant, the entrant negotiates with the incumbent-producer over a license agreement, including a lump-sum payment to the entrant of τ_t. Should an agreement be reached, the incumbent-producer continues in that role to the next period, while the entrant returns to the pool of potential innovators in the next period. If an agreement is not reached, the entrant displaces the incumbent-producer, while the incumbent becomes part of the pool of potential innovators in the next period.

This game is repeated each period with new product innovation resulting in a new round starting with a selection of the innovation leader for that product generation. Fig. 1 depicts the outcomes depending on whether cooperation or competition occurs.

Using this structure, the payoffs of each firm can be derived contingent on the outcomes of stage 1 (the selection of the innovation leader) above. The goal is to understand whether the incumbent or entrant will reach a licensing agreement in stage 4. As with all negotiations, this involves identifying the gains

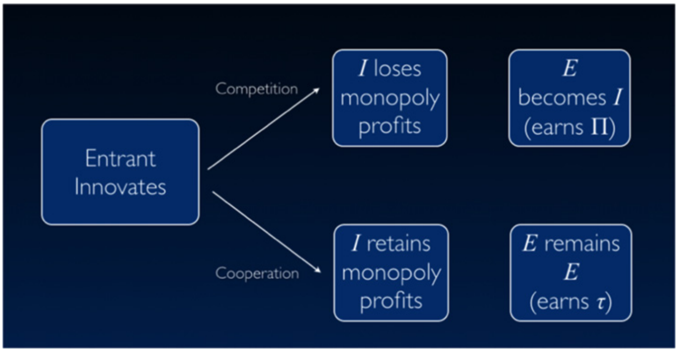

Fig. 1. Consequences of Choosing Cooperation or Competition.

from trade from such an agreement; that is, the increment to joint surplus that results from cooperation as opposed to competition.

If the innovation leader selected is the current incumbent-producer, then only they earn a positive payoff, as the previous entrant (if any) returns to the pool of potential innovators and so has an effectively zero probability of being selected as an innovation leader in the next round. This generates a (net present discounted, expected) payoff to the incumbent of:

$$V_{I,t} = \Pi + \sigma_{ip}\delta V_{I,t+1} + (1-\sigma_{ip})\delta v_{I,t+1}. \tag{VI}$$

Here, the incumbent's expected payoff in period $t(V_{I,t})$ is the sum of the monopoly rents it earns in stage 1 (Π) plus its expected return from being an innovation leader entering the next period ($\sigma_{ip}\delta V_{I,t+1} + (1-\sigma_{ip})\delta v_{I,t+1}$); that is, with probability σ_{ip}, the incumbent will become the innovation leader again, while with probability 1-σ_{ip}, it will be a non-innovating incumbent in the next period and earn $v_{I,t+1}$ (which is derived below).

If the innovation leader is an entrant and it reaches a licensing agreement with the incumbent, then that entrant earns an expected payoff of $v_{E,t}$ while the incumbent earns a payoff of $v_{I,t}$ as follows:

$$v_{E,t} = \tau_t + \sigma_i\delta v_{E,t+1} \tag{vE}$$

$$v_{I,t} = \Pi - \tau_t + \delta\sigma_p V_{I,t+1} + \delta(1-\sigma_p)v_{I,t+1}. \tag{vI}$$

(vE) is comprised of the license fee the entrant receives as well as its expected payoff in the next period where it has some probability, σ_i, of becoming an entrant innovation leader for the next product generation. (vI) is comprised of the license payment to the entrant in return for which the incumbent continues and earns Π in addition to the possibility (with probability σ_p) that it becomes an innovation leader in the future.

Note, however, that if the innovation leader is an entrant and they do not reach a licensing agreement with the incumbent, their payoffs become:

$$v_{E,t} = \delta\sigma_i V_{I,t+1} + \delta(1-\sigma_i)v_{I,t+1} \tag{vE'}$$

$$v_{I,t} = \Pi + \delta\sigma_p v_{E,t+1}. \tag{vI'}$$

(vE)' says that an entrant that is an innovation leader innovates and then earns monopoly rents (Π), and thus it has a probability σ_i of becoming an innovation leader in the next period as an incumbent (earning $V_{I,t+1}$) or, alternatively, being the incumbent in that period ($v_{I,t+1}$). (vI)' says that an incumbent from the previous generation has some probability (σ_p) of converting that incumbency into innovation leadership as an entrant in the next period (earning $v_{E,t+1}$). Note, from (vI)', that, in the competition case, $v_{I,t} < v_{E,t}$ as $\sigma_p\delta < 1$. This is intuitive, since these payoffs are contingent upon an entrant being selected as the innovation leader that then can earn the full value of incumbency. In contrast, at the time these payoffs have been evaluated, the incumbent has been displaced, although it may, on the basis of its production-based capability, become a future innovation leader.

There will be gains to trade through licensing, and hence, agreement if the sum of (vE) and (vI) exceed (vE)' plus (vI)'. That is,

$$\begin{aligned}
&\underbrace{\Pi - \tau_t + \delta\sigma_p V_{I,t+1} + \delta(1-\sigma_p)v_{I,t+1} + \tau_t + \delta\sigma_i v_{E,t+1}}_{\text{Joint Payoff from Cooperation}} \\
&\geq \underbrace{\Pi + \delta\sigma_p v_{E,t+1} + \delta\sigma_i V_{I,t+1} + \delta(1-\sigma_i)v_{I,t+1}}_{\text{Joint Payoff from Competition}} \\
&\Rightarrow (\sigma_p - \sigma_i)(V_{I,t+1} - v_{E,t+1} - v_{I,t+1}) \geq 0
\end{aligned}$$

where it is assumed that if firms are indifferent between licensing or not, they choose to license. In a static sense, a license negotiation merely transfers the monopoly profits for the next generation from the entrant to the incumbent. Hence, there are no gains from trade on this basis alone. However, here there is also a dynamic component to the joint surplus from licensing. Specifically, it defines the role of each firm in producing the new product generation and potentially innovating toward the next product generation. If a license agreement is reached, the current incumbent produces the new product, whereas no agreement will allow the entrant innovator to do so. As there is only one incumbency rent from this, however, it is not a gain from licensing per se, since one or the other firm captures those profits.

However, when the incumbent and entrant have different probabilities of becoming the innovation leader for the next generation, the roles they take impact on the expected profits they earn between them in the future. If they license, the expected joint profits from innovation are $\sigma_p(V_{I,t+1} - v_{I,t+1}) + \sigma_i v_{E,t+1}$ whereas if they do not, these expected joint profits become $\sigma_i(V_{I,t+1} - v_{I,t+1}) + \sigma_p v_{E,t+1}$. Thus, whether this future profit component drives licensing depends upon whether $V_{I,t+1} - v_{I,t+1} > v_{E,t+1}$ (that is, whether joint returns are maximized with an incumbent innovator ($V_{I,t+1}$) than with an entrant innovator ($v_{E,t+1} + v_{I,t+1}$)) and $\sigma_i < \sigma_p$ (the incumbent's probability of becoming the innovation leader is greater than the entrant's). It is easy to see that there are four possibilities in which two have a positive and two have a negative gain from trade. As licensing agreements assign roles, the parties will have incentives to license so they can assign roles that maximize expected future joint profits.

The following proposition utilizes (1) to solve for the equilibrium of the dynamic game. Following Segal and Whinston (2007), the solution concept of the Markov perfect equilibrium is used to narrow the large number of subgame perfect equilibria that might arise. The Markov perfection requires that a firm's actions only depend on the current state of the world – in this case, which firm was the incumbent and which was the entrant in the previous period (Maskin & Tirole, 1988, 2001).[19] Because of this, the equilibrium expected payoffs to each firm will be equal across time; that is:

$$V_{I,t} = V_{I,t+1} = V_I,\ \ v_{I,t} = v_{I,t+1} = v_I \ \text{ and } \ v_{E,t} = v_{E,t+1} = v_E, \ \text{ for all } t.$$

For notational simplicity, we follow Segal and Whinston and simply impose the condition in the discussion that follows. In addition, it is assumed that the previous value of τ is derived using the Nash bargaining solution where the entrant and incumbent have equal bargaining power; hence, $\tau = \delta v_I(1 - \frac{1}{2}(\sigma_i + \sigma_p)) + \delta(V_I - v_E)\frac{1}{2}(\sigma_i + \sigma_p)$.[20] Given this, the following can be demonstrated:

Proposition 1. Licensing is the unique Markov perfect equilibrium if and only if:

$$(\sigma_p - \sigma_i)(\sigma_{ip} - \sigma_i - \sigma_p) \geq 0$$

Otherwise, competition is the unique Markov perfect equilibrium.

The proof (details omitted) proceeds by solving (VI), (vI), and (vE) simultaneously and substituting them into (1), which yields the condition of the proposition. Note that these are the relevant payoffs to consider should one incumbent-entrant pair consider deviating and not agreeing to license.

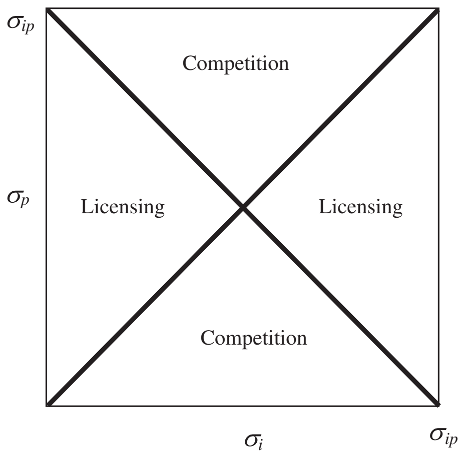

Fig. 2. Licensing Equilibrium Outcomes.

Uniqueness follows by considering what happens should an incumbent and entrant pair expect that payoffs will be those under competition – solving (VI), (vI)', and (vE)' simultaneously – and demonstrating that the same condition as in the proposition determined whether they will license or not.

Fig. 2 depicts the equilibrium outcomes in (σ_i, σ_p) space where, for convenience, it is assumed that $\sigma_{ip} \leq \frac{1}{2}$.[21] Intuitively, Proposition 1 demonstrates that, regardless of whether licensing occurs in equilibrium or not, $V_I \geq v_I + v_E$ if and only if $\sigma_{ip} \geq \sigma_i + \sigma_p$. Specifically, if $V_I \geq v_I + v_E$, the firms want to agree to an outcome that maximizes the probability that one of them becomes an incumbent innovator. If $\sigma_p > \sigma_i$, the current incumbent has the best chance of achieving that position by remaining as an incumbent. Consequently, the firms agree to license in order to preserve the current incumbent's role.

In contrast, if $\sigma_i > \sigma_p$, the current entrant has the greater likelihood of becoming the lead innovator in the next generation. Jointly, the firms want that lead innovator to be the incumbent. To achieve that, they do not license and the current entrant displaces the current incumbent as a producer. Interestingly, the end result is competition.

At this point, it is instructive to return to the informal case-based argument that cooperative commercialization may not be undertaken because the start-up innovator cannot be compensated for a loss of future innovative rents. The argument is that, by licensing, the start-up forgoes the incumbency position and the advantages that brings in terms of future innovative profits. In our formal model here, this factor would be most salient when σ_i is high. When this is the case, an entrant that forgoes licensing has a high probability of becoming an incumbent that is the innovation leader.[22]

However, Proposition 1 demonstrates that this informal argument only partially drives a lack of cooperation in equilibrium. It is not simply that σ_i is large but that σ_i is large relative to σ_p that matters. If that is the case, then, by not licensing, the entrant's chances of becoming an incumbent innovation leader in the next generation are maximized. This provides some formal support for the informal argument. That said, the motivation for the lack of a licensing agreement is to leverage off the entrant's future innovative potential and so, in this respect, captures the spirit of the informal arguments.

Nonetheless, even when $\sigma_i > \sigma_p$, it may be that $V_I < v_I + v_E$. In this case, the firms will agree to license to ensure that the current incumbent's position is preserved. Thus, a relatively high σ_i can drive licensing. In contrast, when $\sigma_p > \sigma_i$, minimizing the likelihood that one of the firms becomes an incumbent innovator involves placing the current entrant in an incumbent producer position. Consequently, they choose to forgo licensing in order to achieve this outcome. Thus, Proposition 1 demonstrates that the informal argument that the entrant's innovation-based capabilities may drive licensing over competition do not necessarily hold up when those capabilities are very high.

In summary, the key dynamic difference between licensing and not licensing is that the identity of the incumbent producer in the current generation changes, and the firms may want to maximize the chances that one of them becomes the innovation leader. When they have asymmetric dynamic capabilities, licensing changes the probability that one of the firms will become the innovation leader; it has been shown that such cooperation may not be to the firms' mutual advantage.

Acquisition

Licensing is not the only form of negotiation for the market. Another commonly practiced outcome involves entrant innovators being acquired by incumbents, perhaps in situations where a licensing agreement is infeasible or not preferred. When an agreement is reached in both licensing and acquisition, the current incumbent retains its incumbency. What happens to the entrant, however, differs in each case. Under licensing, the entrant returns to the pool of potential entrant innovation leaders, and under acquisition, the entrant is removed as a potential independent innovator. Instead, the entrant innovator's capabilities are added to those of the incumbent. Consequently, it is assumed here that this alters – from σ_p to σ_{ip} – the chance that the integrated incumbent will become the innovation leader in the future. Note that this is an idealized view of an acquisition. It says that, in integrating capabilities, an acquisition can achieve the same outcome as if those capabilities were acquired through the joint experience of innovating and producing. In general, it is likely that acquisition will be less perfect. Nonetheless, here I consider when acquisition might be an equilibrium outcome relative to competition and also relative to licensing under these idealized conditions.

The timing of the game is identical to that described above, except that in the negotiation stage, E is negotiating with I over an acquisition. For the moment, it will be assumed licensing is not possible. The implications of relaxing this restriction will be explored below.

There will be gains to trade from acquisition rather than competition if:

$$\underbrace{\Pi - \tau + \delta\sigma_{ip}V_I + \delta(1-\sigma_{ip})v_I + \tau}_{\text{Joint Payoff from Cooperation}} \geq \underbrace{\Pi + \delta\sigma_p v_E + \delta\sigma_i V_I + \delta(1-\sigma_i)v_I}_{\text{Joint Payoff from Competition}} \quad (2)$$
$$\Rightarrow (\sigma_{ip} - \sigma_i)(V_I - v_I) \geq \sigma_p v_E$$

This highlights the difference between the gains from trade from acquisition as opposed to licensing (1). First, acquisition improves the ability of both firms together to earn V_I rather than v_I, which occurs if $\sigma_{ip} \geq \sigma_i$. As noted earlier, it is reasonable to suppose that free disposal, the ability to discard experience, would apply, and so this condition will always hold.

Second, an acquisition causes the firms to jointly forgo a chance of earning v_E. In effect, acquisition might increase the probability that a third party (another potential entrant) becomes the innovation leader. This occurs if $1-\sigma_{ip} > 1-\sigma_i-\sigma_p$ or $\sigma_{ip} < \sigma_i + \sigma_p$. In this case, acquisition confers a *positive externality on potential entrants*; something that is internalized if no acquisition takes place.[23]

Turning to the payoffs in each period, note that V_I remains as in (VI) above but the other payoffs become:

$$v_I = \Pi - \tau + \delta\sigma_{ip}V_I + \delta(1-\sigma_{ip})v_I \quad \text{(vI)''}$$

$$v_E = \tau \quad \text{(vE)''}$$

Using the Nash bargaining solution, τ is given by $\tau = \delta v_I - \delta\sigma_p\frac{1}{2}v_E + \delta\frac{1}{2}(\sigma_i + \sigma_{ip})(V_I - v_I)$. Using this, the following proposition can be proved.

Proposition 2. Acquisition is the unique Markov perfect equilibrium if and only if:

$$\sigma_{ip} - \sigma_i - \sigma_p \geq 0.$$

Otherwise, competition is the unique Markov perfect equilibrium.

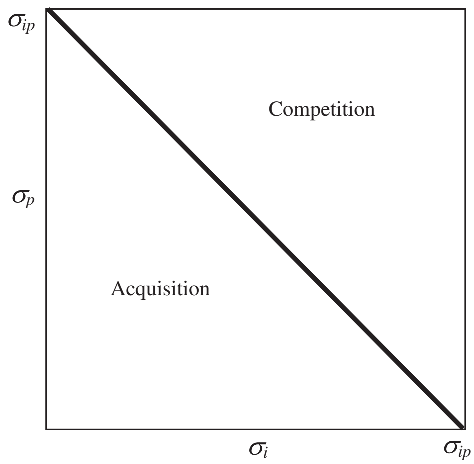

Fig. 3. Acquisition Equilibrium Outcomes.

The proof of Proposition 2 proceeds along the same lines as Proposition 1. Fig. 3 depicts the equilibrium outcomes. Significantly, the gains from trade from acquisition are positive if and only if $\sigma_{ip} \geq \sigma_i + \sigma_p$. In this case, acquisition reduces the probability that a third party (entrant) will become the innovation leader while, in addition, ensuring that the merged firm, should it become the innovation leader, will preserve its combined capabilities for longer. This reflects a common intuition that when there are complementarities (in this case, between production and innovation-based capabilities) integration is preferred to non-integration. As will be demonstrated below, this conclusion is qualified if innovation leaders choose the rate of innovation.

Comparing Licensing and Acquisition

Of course, often, firms may have options of choosing between licensing and acquisition as a mode of cooperative commercialization. Comparing (1) and (2), acquisition will have higher gains from trade than licensing if:

$$\begin{aligned} &\delta(\sigma_{ip} - \sigma_i)(V_I - v_I) - \delta\sigma_p v_E \geq \delta(\sigma_p - \sigma_i)(V_I - v_E - v_I) \\ &\Rightarrow (\sigma_{ip} - \sigma_p)(V_I - v_I) \geq \sigma_i v_E \end{aligned} \tag{3}$$

The interpretation here is quite intuitive. Acquisition yields the benefit of a potentially higher probability of incumbent innovation leadership with the cost of losing a chance at an entrant position in the next generation.

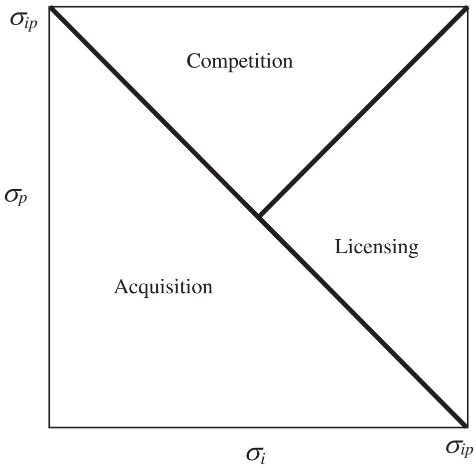

Fig. 4. Licensing vs Acquisition.

Substituting the equilibrium payoff values determined by (VI), (vI), and (vE) (or (vI)" or (vE)" for that matter) into (3) implies that (3) will hold if and only if:

$$\sigma_{ip} - \sigma_p \geq \sigma_i \tag{4}$$

Notice that acquisition is preferred to licensing if $\sigma_{ip} \geq \sigma_i + \sigma_p$; that is, whenever it would otherwise be an equilibrium. This is because acquisition has the additional impact of reducing the probability that third parties become the innovation leader. Fig. 4 depicts the equilibrium outcomes.[24]

EXTENSIONS

The model above is simplified so as to highlight the main dynamic consequences that arise from negotiations for the market. Here, I examine two extensions that illustrate how some additional factors – namely, the static drivers of cooperation and the potential endogeneity of the rate of innovation – affect the results above.

Static Drivers and Product Market Competition

Thus far, the model removes the usual static rationales for cooperative commercialization including avoiding duplicating complementary assets but also preserving monopolistic rents. Here those considerations are reintroduced to see how they interact with the dynamic considerations already discussed above.

Static competition considerations are introduced by following Segal and Whinston (2007), where innovation and entry by an entrant innovator leads to a single period of product market competition. To capture this, suppose that during that period of competition, the entrant, with its superior product, could earn a fraction, α, of monopoly profits, while the displaced incumbent would earn 0. Following that period, as in Segal and Whinston (2007), the entrant would earn monopoly profits for as long as it remained the incumbent.

In this case, two things change. First, under competition, (vE)' becomes:

$$v_E = -\delta(1-\alpha)\Pi + \sigma_i \delta V_I^i + (1-\sigma_i)\delta V_I.$$

Second, the gains from trade from licensing (1) becomes:

$$\begin{aligned} &\underbrace{\Pi - \tau + \delta\sigma_p V_I + \delta(1-\sigma_p)v_I + \tau + \delta\sigma_i v_E}_{\text{Joint Payoff from Cooperation}} \\ &\geq \underbrace{\Pi + \delta\sigma_p v_E - \delta(1-\alpha)\Pi + \delta\sigma_i V_I + \delta(1-\sigma_i)v_I}_{\text{Joint Payoff from Competition}} \\ &\Rightarrow (1-\alpha)\Pi + (\sigma_p - \sigma_i)(V_I - v_E - v_I) \geq 0 \end{aligned} \tag{5}$$

This also implies that the negotiated licensing fee will change to take into account the additional static benefit relative to competition of $(1-\alpha)\Pi$.

This increases the range of parameters in which licensing is an equilibrium. But the question of interest is whether, when the dynamic component is negative, it can outweigh the static benefits, making competition an equilibrium. To see that competition can still be an equilibrium, note that the dynamic components have greater weight, the less the future is discounting. Letting δ approach 1, and substituting in equilibrium values for the payoffs, (5) becomes:

$$1 + \frac{(\sigma_p - \sigma_i)(\sigma_{ip} - \sigma_i - \sigma_p)}{(1-\sigma_i)(1-\sigma_{ip})} \geq \alpha \tag{6}$$

Fig. 5 depicts the resulting outcome.

Now suppose that $\sigma_{ip}, \sigma_p \to 1$, then the LHS of (6) becomes infinitely negative and can never hold. Thus, at this extreme, competition is an equilibrium. On the other hand, the reverse does not hold. That is, as $\sigma_{ip}, \sigma_i \to 1$, (6) becomes positive always. This means that competition, as an equilibrium, when there is potential product market competition, is preserved when $\sigma_p >> \sigma_i$ but not for the reverse. This is because, at those extremes, $\sigma_{ip} < \sigma_i + \sigma_p$, but it is only where productive capabilities are relatively high that firms choose competition so as to maximize the chance that the (previous) incumbent becomes the next innovation leader.

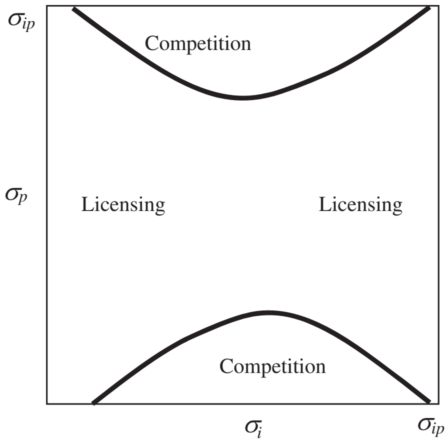

Fig. 5. Licensing Equilibrium Outcomes.

This provides additional insight into the informal argument that a higher σ_i should be associated with competitive rather than cooperative commercialization. When there are short-term gains from cooperation, it turns out that the cases where a higher innovation-based capability leads to competition do not arise because, in this case, joint payoffs are maximized by keeping the entrant in the entrant role, something that is achieved by cooperation and not competition. This is the opposite of what the informal arguments were suggesting.

Endogenous Rate of Innovation

One key aspect of Segal and Whinston (2007) that is abstracted away from in the model here is the choice over the rate of innovation by an innovation leader. In the baseline model, it is assumed that once an innovation leader is selected, that firm generates a new product immediately. To accommodate the notion that innovating may take time, it is assumed that stage 3 – the innovation stage of the game – involves the innovation leader engaging in research efforts until such time as an innovation appears. During that stage, the incumbent earns Π in each period (while periods are still assumed to be discounted by a factor of δ).

Following stage 1, having been selected, the innovation leader continues in that position until an innovation is actually generated. The innovation leader (E or I) chooses research intensity, literally, the probability that an innovation is generated in any given period (ϕ_E or ϕ_I) where the choice lies in the range

$[\phi, 1]$. It is assumed that, regardless of the level chosen, research intensity involves no cost.[25] This simplifies notation because, as proven in Proposition 3 below, incumbent innovators face negative marginal returns to research intensity, while entrant innovators face positive marginal returns. Consequently, in equilibrium, $\hat{\phi}_I = \phi$ and $\hat{\phi}_E = 1$. This allows us to parameterize the life of firm in a particular role, especially the incumbent. Figs. 6A and B depict what happens depending upon whether competitive or cooperative commercialization is chosen.

The fact that $\hat{\phi}_I < \hat{\phi}_E$ adds a new dimension to the value of incumbency. While in the baseline model, $V_I \geq v_I + v_E$ is equivalent to $\sigma_{ip} \geq \sigma_i + \sigma_p$, here, having an incumbent innovator increases the expected life of the current innovation

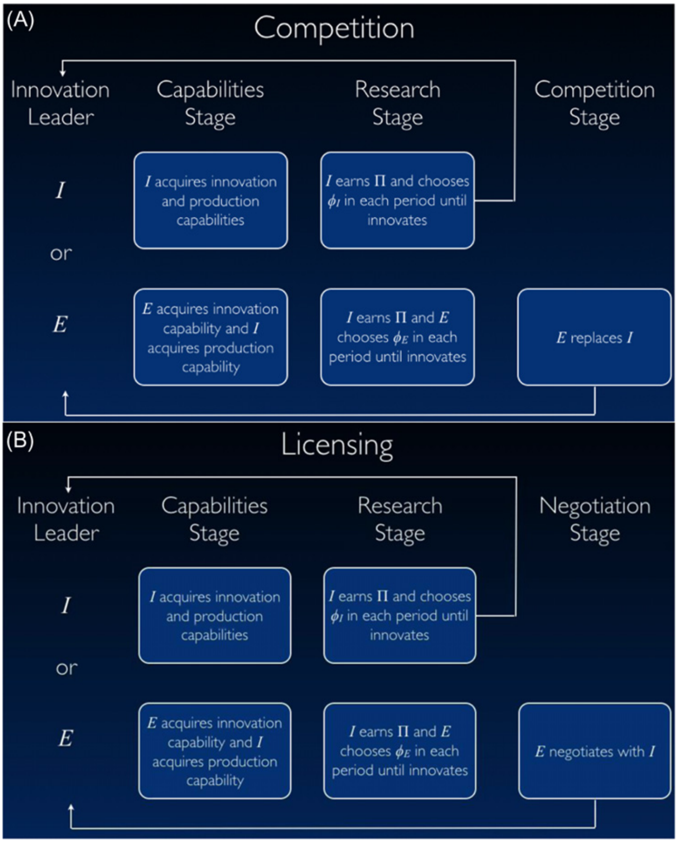

Fig. 6. (A) Innovation When Competition Is Chosen. (B) Innovation When Cooperation Is Chosen.

and the length of time the producer of that product generation can earn monopoly rents. This makes it more likely that $V_I \geq v_I + v_E$ and the incumbent and entrant will want to reach an arrangement that maximizes the probability that one of them becomes an incumbent innovation leader. The insight drives the following result:

Proposition 3. Licensing is the unique Markov perfect equilibrium if and only if:

$$(\sigma_p - \sigma_i)\big(1 - \phi(1 - \sigma_{ip}) - \sigma_i - \sigma_p\big) \geq 0.$$

Otherwise, competition is the unique Markov perfect equilibrium.

The critical elements of the proof of this is the recognition that (1) still determines the gains from trade, while the returns to an additional unit of innovation intensity by the entrant is given by $\tau - (1 - \sigma_i)\delta v_E > 0$ and the return to the incumbent is given by $(1 - \sigma_{ip})\delta(V_I - v_I) < 0$. This results in the incumbent choosing the minimum innovation rate to reduce the risk of losing control as an innovation leader, while the entrant innovates more intensively so as to earn the license fee sooner. The details of the proof are in Gans (2010).

Licensing serves a similar dynamic role to that in the baseline model. The choice of whether to license or not determines who is likely to become an incumbent innovation leader. In this case, having an incumbent innovation leader increases the value of the innovation and so it is more likely that V_I will exceed $v_I + v_E$ even if $\sigma_{ip} < \sigma_i + \sigma_p$. Thus, the qualitative results from the baseline model continue to hold. However, it is now the case that the choice of licensing, which is conditional on relative innovation-based and production-based capabilities, will have an impact on the rate of innovation observed in the industry.

This interaction is stronger when the parties negotiated over whether an entrant firm is acquired by the incumbent. In this case, acquisition occurs if and only if $\sigma_{ip} - \sigma_i - \sigma_p \geq -\delta(1 - \phi)\sigma_p(1 - \sigma_{ip})$. Notice that this is a weaker condition than in Proposition 2 and now $\sigma_{ip} \geq \sigma_i + \sigma_p$ is not a necessary condition for acquisition. Moreover, whenever acquisition takes place, it results in a lower than expected rate of innovation in the industry.

Finally, the relative returns to acquisition over licensing are also affected by the reduced incentives of an incumbent innovation leader. Specifically, acquisition occurs rather than licensing if and only if $\sigma_{ip} - \sigma_p - \sigma_i \geq -\delta(1 - \phi)\sigma_i(1 - \sigma_{ip})$, which again is a weaker condition than (4). Thus, the returns to acquisition over licensing are higher when the incumbent has the ability to slow down the rate of innovation.

ALTERNATIVE CONTRACTING POSSIBILITIES

In the baseline model, the only opportunity for a commercialization choice to be made is when an entrant develops a new innovation. At that point, there is still uncertainty as to who will be the innovation leader in the next generation. Consequently, the choice involves a commitment to the roles each firm assumes in the industry prior to the resolution of that uncertainty. This is natural timing given that such uncertainty may be resolved long after the innovation is generated and the empirical evidence suggests that cooperative agreements, if they occur, are struck close to the time a patent is generated (see Gans et al., 2008).

Nonetheless, it is useful to consider alternative contracting possibilities that alter the timing upon which commercialization choices or roles in the industry might be selected. In this section, I consider three such variations, including restructuring by an incumbent, delayed negotiation or renegotiation, and partial capability acquisition. These provide alternative predictions on commercialization choices that may be applicable in certain empirical environments.

Restructuring and Spinouts

In the model thus far, the only way an incumbent innovator can emerge is if an incumbent producer of the current generation becomes the innovation leader for the next generation, allowing it to acquire innovation and production-based capabilities together. This is desirable if $\sigma_{ip} \geq \sigma_i + \sigma_p$, implying that an incumbent innovator receives a higher payoff than the sum of returns to an incumbent and an entrant innovation leader.

However, what if $\sigma_{ip} < \sigma_i + \sigma_p$? In this case, an incumbent innovation leader earns a lower payoff than if it and an entrant innovation leader were separate. In this case, an alternative option that may be available would be for the incumbent, having been selected as an innovation leader and acquired the "know how" to innovate toward the next product generation, to restructure itself. That is, rather than continue to research and acquire, within the same firm, both production and innovation experience, it could *spin out* a separate innovator entrant from the incumbent producer.[26]

If such restructuring were feasible and separate firms could specialize in producing the current generation and innovating toward the next, what impact would this have on observed outcomes in negotiation for the market? For both licensing and acquisition, this would only change outcomes where $\sigma_{ip} < \sigma_i + \sigma_p$, because otherwise no restructuring would take place. Thus, it would not impact on the acquisition case. In the licensing case, the fact that restructuring could occur implies that $V_I = v_I + v_E$. Examining (1), the gains to trade from licensing become zero and so static drivers would be expected to dominate in the commercialization choice.

Entrant Participation in Production

While direct renegotiation over production rights that allows production- and innovation-based capabilities to coevolve may not be possible, one practice that has been observed is start-up innovators negotiating co-promotion and other production-related rights as part of licensing deals. For instance, Wakeman (2010) identifies that about one-third of all start-up deals in his biotechnology sample involved start-up firms retaining roles in marketing, sales, clinical trials, and development collaboration.[27] While his interpretation of such arrangements is to increase a start-up's ability to commercialize independently in the future, it is also possible that this is a means of gaining experienced-based capabilities that combine innovation and production elements. In other words, rather than having just σ_i as the probability of becoming a future innovation leader, this arrangement allows the start-up to generate a probability, $\sigma'_{ip} \in (\sigma_i, \sigma_{ip})$, of becoming the next innovation leader.

There are several implications of this possibility on the analysis thus far. First, the condition as to whether such a licensing arrangement is entered into or not becomes:

$$\begin{aligned} &\underbrace{\Pi - \tau + \delta\sigma_p V_I + \delta(1-\sigma_p)v_I + \tau + \delta\sigma'_{ip}v_E}_{\text{Joint Payoff from Cooperation}} \geq \underbrace{\Pi + \delta\sigma_p v_E + \delta\sigma_i V_I + \delta(1-\sigma_i)v_I}_{\text{Joint Payoff from Competition}} \\ &\Rightarrow (\sigma_p - \sigma_i)(V_I - v_I - v_E) \geq (\sigma_i - \sigma'_{ip})v_E \end{aligned} \tag{7}$$

which involves a larger set of parameters than in Proposition 1 holding σ_p constant (although strictly speaking, that parameter is likely to be lower as a result of such an arrangement). Second, comparing licensing to acquisition, $(\sigma_{ip} - \sigma_p)(V_I - v_I) \geq \sigma'_{ip}v_E$ is less likely to hold meaning that acquisition may not occur even if $\sigma_{ip} \geq \sigma_i + \sigma_p$. This is intuitive as the capabilities transferring properties of licensing have improved. Finally, it is easy to see that the license payment to the start-up firm will be smaller, the higher σ'_{ip} is. This is consistent with Wakeman's (2010) evidence that start-up firms that are in a stronger financial position (i.e., less cash constrained) are more likely to enter into co-promotion licensing deals with incumbents.

Delayed Negotiation

When $\sigma_{ip} \geq \sigma_i + \sigma_p$, an incumbent and entrant have a joint interest in maximizing the probability that the producer of the current generation is also the innovator for the next generation. In the baseline model, negotiations over which firm is that producer take place prior to the determination of which firm is the innovation leader in the industry. Consequently, while negotiations allow the parties to increase the likelihood that one of them becomes the innovation leader, after the fact, that still may not arise.

The issue to be examined here is whether there are actions the incumbent and entrant can take to eliminate that risk. For instance, one possibility would be to delay any negotiations until it is determined which firm is the innovation leader. If the innovation leader turns out to be the previous entrant, no negotiations will take place and that entrant will become an incumbent innovation leader. If the innovation leader turns out to be the previous incumbent, a licensing deal will arise with the production rights transferred to the firm that can continue to acquire a production-based capability alongside innovation-based capabilities. Interestingly, the same licensing deal is possible even if the innovation leader turns out to be a new entrant.

These considerations imply that, if the innovation leader is an entrant, the payoffs to that entrant and the current incumbent at the end of the previous period that involved an entrant innovation leader are:

$$v_E = \delta(\sigma_i V_I + (1 - \sigma_i)\tau) \tag{8}$$

$$v_I = \Pi + \delta\sigma_p(V_I - \tau). \tag{9}$$

That is, an entrant innovator expects to become an innovation leader with probability σ_i and to otherwise sell its production rights while a non-innovating incumbent expects to earn the monopoly rents and, if it becomes the innovation leader, it expects to purchase production rights from the previous entrant.

What is interesting here is that the licensing deal may not be between the entrant and incumbent but between the entrant innovator and a new entrant. In either case, the sale of a production rights creates an incumbent innovation leader as opposed to having a separate entrant innovator and non-innovating incumbent. Thus, using the Nash bargaining solution, $\tau = \frac{1}{2}(V_I + v_I - v_E)$. Substituting this and solving using (VI), (8), and (9), it is straightforward to show that a licensing agreement will be reached if and only if $\sigma_{ip} \geq \sigma_i + \sigma_p$. Compared to Proposition 1, this expands the domain where a license agreement is reached relative to where competition occurs.

Delayed negotiation is not the only means by which this outcome could arise. In general, *renegotiation* can take place whereby a licensing deal is undertaken prior to the selection of the next innovation leader and, upon that selection, whoever holds production rights to that product generation negotiates to sell them to the innovation leader.

That said, the scope for renegotiation depends critically upon the incidence of the acquisition of production-based capabilities. The baseline model – for notational convenience – sets the timing of the acquisition of these capabilities to be after the selection of the next innovation leader. However, it is easy to imagine many instances whereby the acquisition of those capabilities occurs when the new product innovation is generated, which is well before the next innovation leader is revealed. In this case, the only time whereby licensing or other forms of cooperative commercialization can determine which firm realizes those production-based capabilities is prior to the resolution of uncertainty as to which firm might acquire complementary innovation-based capabilities. Put simply, in some environments, there may be no simple way of using contracts to combine the two types of capabilities. That said, ultimately, whether this is possible or not is an empirical issue.

EMPIRICAL IMPLICATIONS AND FUTURE DIRECTIONS

This is the first chapter to consider start-up commercialization strategy within a formal model of dynamic innovation. It was demonstrated that dynamic considerations impact on this decision in a way not captured by a purely static focus. In particular, the ongoing roles of the parties to a licensing deal matter in terms of rent capture and the returns to licensing over competition. In turn, these ongoing roles are related to dynamic capabilities – in this chapter, the probability that a firm will have an innovative advantage in research toward the next generation of product based on experience in its current role (as producer and/or innovator).

In this regard, the most interesting finding was that entrants and incumbents may not sign cooperative licensing agreements even though this would prevent the dissipation of monopoly profits and duplication of complementary investments. This occurred because to do so would send the entrant back to compete for the next generation of innovation in situations where the incumbent had stronger capabilities in this regard. This naturally leads to whether the firms could choose which one of them would return to innovative competition and which one would remain as the incumbent.

This is an interesting issue and in many respects goes to the heart of what a dynamic capability is and how it is acquired. An incumbent is likely to be strong because of its previous product market position and this likely relates to investments it has made in the past. An entrant would have to similarly make those investments to strengthen its future role and, thus, one of the gains from licensing (preventing such duplication) would be lost. In addition, with antitrust laws, it is not clear that the incumbent could cede its product market position so readily. Non-exclusive licensing might play a role here but there would be some ongoing dissipation of monopoly rents. Similarly, the entrant could acquire the incumbent. However, this might necessarily preclude the entrant from becoming a strong innovative firm unless some form of restructuring was possible. Thus, there appears to be substantive reasons why changing positions is not a simple choice, and so it is natural to explore innovative dynamics when this is impossible. However, a proper exploration of these issues remains an open area for future research.

Perhaps the most fruitful direction for future research is to explore empirically the predictions derived here. Figs. 1, 2, and 3 provide a clear set of empirical predictions as to when we might expect to observe cooperative rather than competitive commercialization. The empirical challenge in verifying this theory is in finding proxies for the dynamic capabilities themselves. While these will likely reflect the market and institutional structure of industries under study, the dynamic capabilities here are specifically related to experience in various previous activities. For example, the production-based dynamic capability could be captured by variables that identify experience in production, including the number of product launches, the level of past sales, and the longevity of the firm as a producer. The innovation-based dynamic capability could be captured by measures of innovative experience, including the level of past research and development and the stock of patents generated. For firms that have both innovation and production experience, these measures would have to be interacted to capture any synergies that might arise.[28] Thus, the theory provides a basis for the collection of data to understand the dynamic drivers of commercialization choice.[29]

On the purely theoretical side, there are several other directions in which the results of this chapter could be extended and explored in future research. First, in this chapter, dynamic capabilities were considered as fixed probabilities. Either firms acquired them as a result of experience (to a certain degree) or they did not. In reality, the acquisition of such capabilities and their intensity is likely to be a key and ongoing strategic choice for firms. Thus, endogenizing the level of capabilities alongside who acquires them and relating those capabilities to more fundamental market conditions (as in Sutton, 2002) would appear to be a promising avenue for future research. The model here provides a framework upon which such an extension might be based.

Finally, this model shares with many a simple consideration of innovative strategy – namely, innovative intensity. Adner and Zemsky (2005) go beyond this to consider impacts on other strategic variables such as prices, market monitoring, firm size, and the rate of overall technological progress. Their model is dynamic but does not consider the choice of commercialization strategy – it only considers a competitive route for start-ups. Linking their approach with the endogenous choice of commercialization strategy can lead to a richer picture of the innovation environment and the role of disruptive technologies.[30]

NOTES

1. Some hints of this arise in the work of Wasserman (2006) and Dushnitsky (2010), who have emphasized entrepreneurial preference and optimism, respectively. There are also discussions in various cases that have documented internal debates in innovative organization regarding the merits of selling out too early (see Bartlett, 1983; Cape, 1999; Casadesus-Masanell, Boudreau, & Mitchell, 2010). In each of those cases, eventually cooperative commercialization was pursued, but not before some concern for the ability to capture future innovative rents was postulated and become part of intense and active deliberations.

2. Those capabilities may come externally – through entry. Alternatively, they might be developed internally by those who are currently innovating toward the next product generation. In this respect, a firm is said to have a dynamic capability if it can successfully engage in development of the product generations beyond that being developed today.

3. It is useful to distinguish such experience-based capabilities from dynamic managerial capabilities (Adner & Helfat, 2003, p. 1012) that "are the capabilities with which managers build, integrate, and reconfigure organizational resources and competences." Clearly, if established firms have such capabilities that will make cooperative commercialization more likely, they are likely to be a driver of such commercialization (as emphasized by Gans & Stern, 2003). The same is true of dynamic capabilities that reinforce network cohesion and efficiency (Rothaermel & Hess, 2007). However, as our focus here is on finding drivers to explain the incidence of competitive commercialization, we do not consider these in the discussion that follows.

4. A firm's experience in these activities is something that is potentially measurable. For instance, experience in innovation may be measured by accumulated patents while experience in production may be measured by a firm's position in sales of previous product generations.

5. For an examination of the capabilities of incumbents in this regard, see Hill and Rothaermel (2003), while Helfat (1997) provides a general treatment that includes what is termed here "production" capabilities.

6. Segal and Whinston (2007) did remark upon the possibility of licensing but did not explore it. Other work on cumulative innovation similarly does not endogenize the commercialization choices of start-ups (see, for example, the survey by Scotchmer, 2004).

7. In actuality, the model explicitly allows for many firms and this is critical to the analysis and conclusions. However, through simplifying assumptions, I derive a situation where consideration is required of only two active firms at any given stage of the dynamic game.

8. Segal and Whinston (2007) allow for a period of temporary competition between an entrant innovator and an incumbent. This possibility is explored in section 5 below.

9. By focusing purely on dynamic considerations, we can abstract away from complementary strategic effects whereby current commercialization alters strategic position in future innovation races. As described theoretically by Stefanadis (1997), maintaining a downstream presence can potentially deny innovative rivals access to scale economies, while Somaya (2002) notes such barriers to patent litigation settlements. A similar effect was noted by Segal and Whinston (2007). However, in each of these cases, when cooperative commercialization is possible, the impact of these issues is to shift the distribution of rents from such commercialization rather than change their choice per se. In contrast, the analysis here will show how and when dynamic considerations can actually drive competitive commercialization choices.

10. Allowing for innovators to continue as potential future innovators reflects reality. Specifically, there are many instances where future innovative potential rests with those

who have innovated in the present. For instance, Niklas Zennstrom and Janus Friis founded the peer-to-peer file sharing network KaZaA, which was acquired by Sharman, before moving on to found the peer-to-peer IP telephony network Skype, which itself was acquired by eBay. They have now moved into IP television with a new venture, Joost. In each case, they have leveraged skills to become a lead innovator in the next generation of peer-to-peer and fast-transfer Internet technologies. Similarly, Biz Stone created the successful web log platform Blogger, which he sold to Google and then went on to co-found Twitter, built on the same intuition about the value of social networking.

In other cases, the leverage of dynamic capabilities has led to direct competition for the initial venture. Steve Jobs founded Apple in the 1970s but left in 1986 following disagreements on firm direction to found NeXT and Pixar. Ten years later NeXT was acquired by Apple with its operating system and went on to become the core of the highly successful OSX. Pixar was acquired by Disney in 2006. Similarly, Walt Disney, having been rebuffed and having his animation ideas expropriated by several studios, went on to found his own company and dominate the entire industry (Gabler, 2006). In contrast to Jobs (whose technologies and skills were acquired), Disney was to use his dynamic capabilities to take on established firms in the product market and make himself the market leader.

11. The term "monopoly rents" does not necessarily mean that the incumbent is unconstrained in its pricing over the product. It is just that it commands 100 percent of the market although the price it charges might be constrained by product generations past. Π represents those potentially constrained profits.

12. Segal and Whinston (2007) make a similar assumption that once a new product innovation is generated, the previous innovation is placed in the public domain. In Section 3, I relax these assumptions and consider what happens if negotiation leads to the control of two generations of patent rights and price accordingly.

13. Notice that this is a clear departure from the assumption of Segal and Whinston (2007) that only two firms in the industry are potential innovators over the entire course of time.

14. As Erkal and Scotchmer (2009) observe, this setup captures the notion that good ideas are somewhat scarce as opposed to an assumption made by many economists that they are abundant and the resources to develop them are scarce.

15. Thus, the advantage of leveraging production experience (and, as will be seen, innovator experience) lasts only to the next generation and depreciates completely beyond that. Note that it is possible that an incumbent's production capabilities are small (i.e., $\sigma_p \approx 0$). Past research (e.g., Bresnahan, Greenstein, & Henderson, 2012; Henderson, 1993; Henderson & Clark, 1990) has demonstrated that, in some industries, past experience as an incumbent is not conducive to generating superior capabilities. The model here allows for the full range of possibilities on incumbent advantage or disadvantage in this regard.

16. This is a common presumption in innovative industries; see Teece (1987).

17. It is implicitly assumed that if E were to engage in non-exclusive licensing, then the resulting ongoing competition between two firms in product markets would be so intense as to make entry non-credible. Of course, licensing terms can be utilized to soften such competition. In this case, however, the profit impacts of an exclusive and non-exclusive license would be the same.

18. In a non-cooperative bargaining model, Gans and Stern (2000) show that this outcome is the upper bound on the entrant's bargaining power when IP protection is potentially weak and the incumbent can invest in work-around technologies.

19. Markov perfect equilibrium is a commonly used refinement of subgame perfect equilibrium for dynamic games. Its chief use is to remove supergame-type punishments from the infinitely repeated game. The equilibria analyzed in this paper are all subgame perfect.

20. It should be noted, however, that the conclusion would be unchanged even for a more general bargaining outcome so long as the entrant and incumbent were each (weakly) better off by agreeing to the license agreement versus entering into competition with one another.

21. If this wasn't the case, then there would be a triangular area on the top right-hand corner of the diagram where $\sigma_i + \sigma_p > 1$, which is outside the range of feasible outcomes, but otherwise the areas for each equilibrium outcome would be roughly the same.

22. Arguably, this was the basis of the debates and arguments in favor of not licensing in the EMI, Ecton and Palm cases. Those cases focused on just that aspect but in two cases ended up with outcomes involving cooperation. It is possible, therefore, that other considerations – both static and also with regard to production-based capabilities – played a role in actuality. However, we cannot observe that from the case record.

23. Note that if the "principle of selective intervention" is applied, then it could not be the case that $\sigma_{ip} < \sigma_i + \sigma_p$. However, as noted earlier, it may be that to take advantage of this would require restructuring. In its absence, a firm might still choose to integrate its capabilities at some technical loss in efficiency if there were other advantages from so doing.

24. Of course, this assumes frictionless deliberations, thereby avoiding complications as documented by Dyer, Kale, and Singh (2004).

25. This can easily be introduced with little change to the results (see Gans, 2010). In addition, Gans (2010) demonstrates that more than one firm can be innovating towards a new product generation and the results below are largely unchanged.

26. Klepper and Sleeper (2005) and Agarwal, Echambadi, Franco, and Sarkar (2004) document how spin-outs can take "know-how" out of firms where such know-how is identified to exist. This suggests that capabilities are, in some cases, resources that can transition over firm boundaries. This contrasts the view of spin-offs that emphasizes the control of intellectual property (e.g., Anton & Yao, 1995; Hellman, 2007).

27. Johnson (2002) also observed that firms may gain experience through continued licensing with established firms.

28. While clearly not focused on the issues presented in this paper, some progress along this dimension has been made by Puranam, Singh, and Chaudhuri (2009). They have shown that interdependence in capabilities (particularly, shared knowledge) could drive acquisition over different types of cooperation.

29. Eesley, Hsu, and Roberts (2009) have studied the importance of founder characteristics on start-up firm performance using a significant survey of MIT alumni and their commercialization choices. It is possible that such surveys could be paired with subsequent experience data to test the hypotheses generated in the model here.

30. One such model is provided by Marx, Gans, and Hsu (2014).

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