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NEGOTIATING FOR THE MARKET

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ABSTRACT

In a dynamic environment where underlying competition is "for the market," this paper 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.

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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 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 inevitably when incumbents and entrants can reach agreements that subvert that outcome (Salant, 1984; Gans and Stern, 2003); 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 and 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. In particular, although some complementary assets may be freely available so that start-ups can contract for access to them to enter product markets, product market incumbents can tightly hold onto other assets. In the latter instance, Teece argued that start-ups will be better off avoiding product market activities altogether in favor of licensing and similar deals that make them sellers of innovations or intellectual property (see also Arora, Fosfuri and Gambardella, 2001).

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*. Put simply, monopoly profits, which can be realized under cooperative commercialization, are greater than the sum of duopoly or oligopolistic profits that arise under competitive commercialization, thereby giving start-ups and incumbents strong incentive to engage in licensing or acquisition deals that prevent the start-up from entering product markets.

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 and Stern, 2003). However, these costs may arise even when entering product markets (Grossman and Hart, 1986), and, when considering implications in a nuanced way, would delay cooperative commercialization rather than drive competitive commercialization per se (Gans, Hsu and Stern, 2008; Allain, Henry and Kyle, 2011).

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 and 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 and Ceccagnoli, 2006). Gans, Hsu and Stern (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 which 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 to 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 paper is to bring together the literature on dynamic capabilities 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.

To achieve this, there are some key modeling choices that must be made. 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, Pisano and Shuen (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

[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 and 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 towards 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.

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 and 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 is to respect 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. 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

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[3] It is useful to distinguish such experience-based capabilities from dynamic managerial capabilities (Adner and 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 and Stern, 2003). The same is true of dynamic capabilities that reinforce network cohesion and efficiency (Rothaermel and 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.

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 and 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 set-up with potentially short-lived firms as well as long-lived innovators is developed.[10] Consequently, the model

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[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 4 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

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 and Stern, 2000).

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. That value is itself endogenous in a dynamic environment, and it is demonstrated that it can be sometimes lower under licensing than under competition.

Second, as noted above, a key finding here is that the gains from trade from licensing may not always be positive. In a situation where the dynamic capabilities are very asymmetric, licensing means that some future innovative rents might be jointly forgone by the current incumbent and entrant. In contrast, competition means that such rents (even if they are lower) are captured by current firms – as the entrant becomes the incumbent and the incumbent becomes the next entrant. Thus, 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 paper proceeds as follows: in section 1, the basic model is introduced; in section 2, 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. Section 3 considers a number of extensions, including static product market competition and an endogenous rate of innovation. Section 4 considers alternative contracting possibilities that may impact on observed commercialization choices. A final section concludes the discussion.

1. Model Set-Up

In this section, I describe the basic set-up of the model. It is designed to capture the key elements

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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.

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 there is a single producer (*I*) of that new product 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, following a successful innovation, a firm is present in the market during the development of the next generation and the possibility that it is not. As noted earlier, for most models of patent races and innovation, displaced incumbents exit the industry while; 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, Scotchmer and Thisse (1998), the innovation leader for a product generation is randomly drawn from a

[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.

pool of firms (infinite in number) and including the current incumbent that could potentially innovate.[13] This structure amounts to assuming that the "know-how" of how to progress towards the next product innovation is acquired by a single firm that can then exploit it by engaging in research towards 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 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 and 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 (*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 becomes the innovation leader for the next generation (the subscript *p* here standing for innovative capabilities generated by virtue of being a *p*roducer). This might be as an incumbent or entrant, depending on whether cooperative commercialization occurs or not. 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

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[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 set-up 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., Henderson, 1993; Henderson and Clark, 1990; Bresnahan, Greenstein and Henderson, 2010) 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.

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 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 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 paper, 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. As will be demonstrated below, a choice of cooperative commercialization can determines 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 (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. 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

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

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 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.

2. 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 towards 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.

[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.

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 over a license agreement, including a lump-sum payment to the entrant of τ_t. Should an agreement be reached, the incumbent 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 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.

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 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, then only the incumbent earns 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:

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

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:

$$v_{E,t} = \tau_t + \sigma_i \delta v_{E,t+1} \qquad \text{(vE)}$$

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

(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:

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

$$v_{I,t} = \Pi + \delta\sigma_p v_{E,t+1}. \quad \text{(vI)'}$$

(vE)' says that an entrant that is an innovation leader, innovates and then earn 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,

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

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 towards 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 and 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. 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.

[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.

Figure 1: Licensing Equilibrium Outcomes

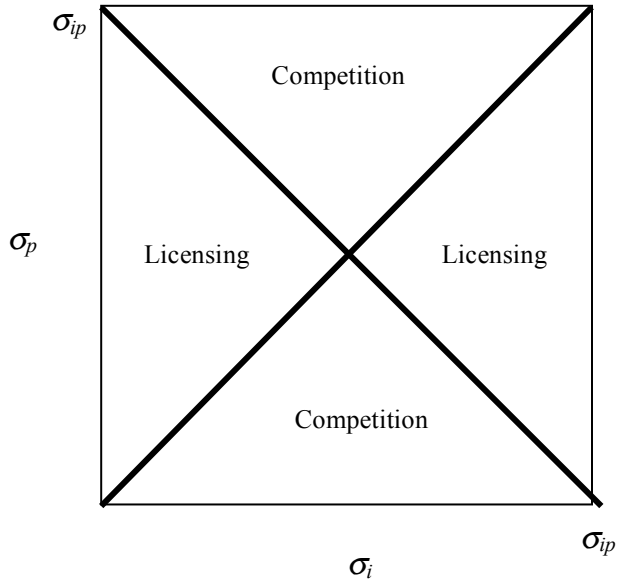


Figure 1 depicts the equilibrium outcomes in (σ_i, σ_p) space where, for convenience, it is assumed that $\sigma_{ip} \leq \frac{1}{2}$.[21] Intuitively, Proposition 1 demonstrates that, regardless of whether licensing occurs in equilibrium or not, $V_I \geq v_I + v_E$ if and only if $\sigma_{ip} \geq \sigma_i + \sigma_p$. 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,

[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.

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

[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.

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 $\tau = \delta v_I - \delta\sigma_p \tfrac{1}{2} v_E + \delta \tfrac{1}{2}(\sigma_i + \sigma_{ip})(V_I - v_I)$. Using this, the following proposition can be proved.

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

---

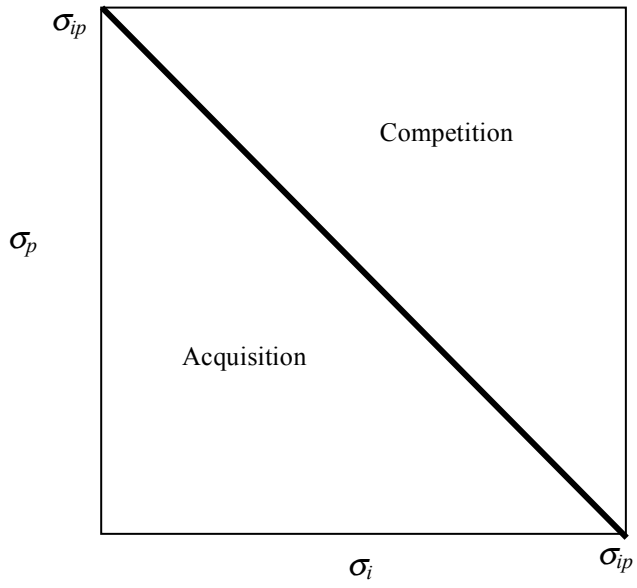
[23] Note that if the "principle of selective intervention" applied then it could not be the case that $\sigma_{ip} < \sigma_i + \sigma_p$. However, as noted earlier, it may be that to take advantage of this would require restructuring. In its absence, a firm might still choose to integrate its capabilities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

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

Otherwise, competition is the unique Markov perfect equilibrium.

The proof of Proposition 2 proceeds along the same lines as Proposition 1. Figure 2 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.

Figure 2: Acquisition Equilibrium Outcomes



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

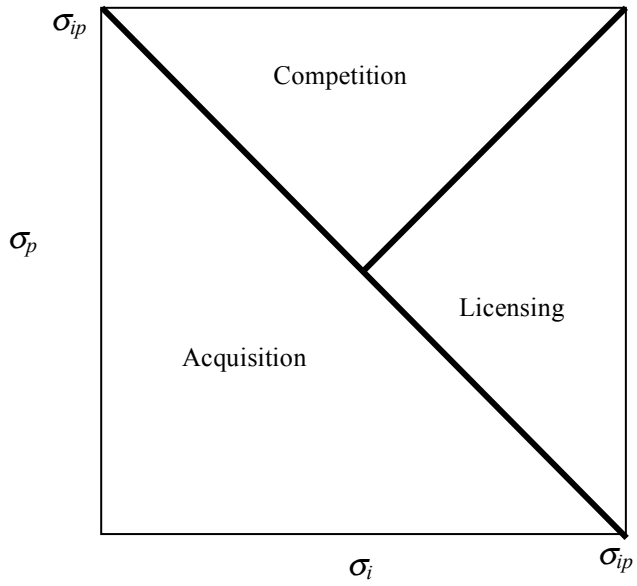
generation.

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. Figure 3 depicts the equilibrium outcomes.[24]

Figure 3: Acquisition versus Licensing



3. 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

In Segal and Whinston (2007), innovation and entry by an entrant innovator leads to a single

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

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:

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

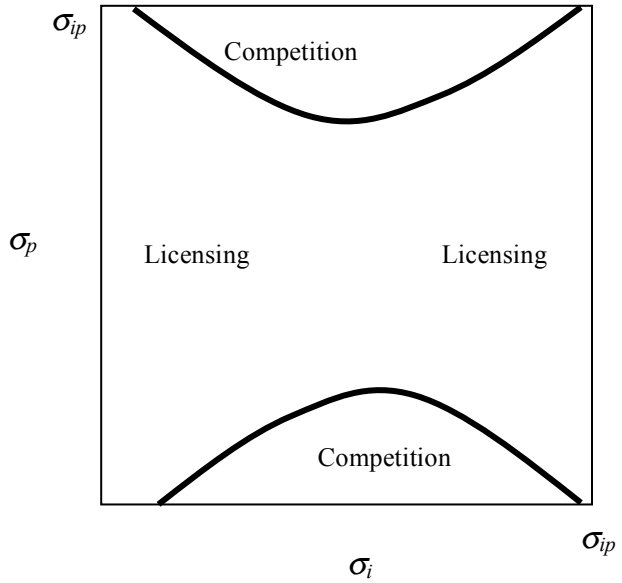
This also implies that the negotiated licensing fee will change to take into account the additional static benefit relative to competition of $(1-\alpha)\Pi$.

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:

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

Figure 4 depicts the resulting outcome.

Figure 4 Licensing Equilibrium Outcomes



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 $\sigma_{ip}, \sigma_i \to 1$, then (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.

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.

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 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:*

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

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

[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.

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.

4. 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, Hsu and Stern, 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 spin-outs

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 towards 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 towards 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 co-evolve 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

[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 and Yao, 1995; and Hellman, 2007).

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

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:

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

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

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.

5. Empirical Implications and Future Directions

This is the first paper 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 paper, the probability that a firm will have an innovative advantage in research towards 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. Figures 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 paper could be extended and explored in future research. First, in this paper, 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 others 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]

[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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