Negotiating for the Market*

by

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In a dynamic environment where underlying competition is 'for the market,' this paper examines what happens when entrants and incumbents can 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 firms' 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. It is also demonstrated that, in this environment, firms may have incentives to license or not precisely adverse to the welfare benefits of such actions and that acquisition is always socially undesirable. *Journal of Economic Literature* Classification Number: O31.

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Advocates of mechanisms such as patent rights and relaxed antitrust laws often argue that while such rights can diminish competition *in* a market, they increase the degree of competition *for* the market. Of course, it is well-known that this trade-off depends on whether those policies themselves generate inter-temporal persistence of present market power (Scotchmer, 2004). For instance, broad patents and antitrust practices (such as exclusionary contracting) 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 a given when incumbents and entrants can reach agreements that subvert that outcome (Salant, 1983; Gans and Stern, 2003). That is, when they can *negotiate* for the market.

From an industrial organization perspective, there is a presumption that, if given the opportunity, incumbents and entrants would negotiate rather than compete for the market. Not only would this minimise any competition that might arise between them, it would also save on any costs faced by the entrant in engaging in production (Teece, 1987). That said, negotiation breakdown or avoidance could arise from the weakness of property rights, information asymmetry impeding efficient bargaining or high search costs for cooperative partners (Gans and Stern, 2003). When this arises, competition for the market would be observed.[1]

Despite the dynamic motivation for considering competition versus negotiation for a market, the reasons outlined above are essentially static. Neglected are concerns by, say, an entrant, that, by negotiating for a market with an incumbent, they would be forgoing an option

[1] Teece (1987) emphasized that cooperation was mutually beneficial for incumbents and start-ups as it avoided the duplication of critical complementary assets that would be required when start-ups chose to enter product markets. Gans and Stern (2000) built on this and explored the way in which licensing might avoid the dissipation of monopoly rents but also how intellectual property protection might facilitate such cooperative commercialization by removing expropriation risk that might otherwise cause start-ups to avoid direct negotiations with incumbents (see also Anton and Yao, 1994; Arora, 1995). These drivers of cooperative commercialization – that is, the importance of complementary assets and the strength of intellectual property protection – were borne out in empirical investigations by Gans, Hsu and Stern (2002), Arora and Ceccagnoli (2005) and Hsu (2006) who also considered the importance of intermediaries in markets for ideas as facilitators of cooperation across industries.

to become the incumbent and build up any resulting advantages themselves. For example, many business school teaching cases examining similar choices faced by start-up firms highlight important internal debates regarding the immediate gains from cooperation (through licensing or acquisition) versus the concern that the start-up might be selling out too early and losing their 'birthright' to future innovative returns (Bartlett, 1983; Cape, 1999) or otherwise "mortgaging away" their company's future (Pisano, 1994, p.10). These cases hypothesize that, when a start-up firm has opportunities for developing innovations in the future, by cooperating with incumbents today, those opportunities are potentially diminished. Indeed, the participants in the cases appear to suggest that this future cost may be so great that a start-up firm should consider avoiding licensing and cooperation altogether.

To an economist, such possibilities are generally seen as being another factor in the price of cooperation: namely, an entrant would have to be compensated for any reduction in its ability to innovate in the future. However, even recognizing this, it may be that the gains to trade between established firms and entrants are low or negative when the impact of future innovative competition is taken into account. Therefore, to properly take these considerations into account requires a dynamic model.

This paper constructs a model designed to capture the key elements associated with this issue. First, the market that firms may be competing or negotiating for is the development of the next generation of a product. Second, if that next generation product is developed by an entrant, rather than the incumbent supplier of the previous generation, the patent associated with that increment can be sold and transferred to the incumbent. Third, the experience associated with innovating and producing the current product generation endows firms with capabilities to innovate and develop the next product generation; specifically, being selected as the innovation leader for that next generation. These capabilities, however, are assumed, initially at least, to be non-transferable between firms. As will be shown, this adds a future or dynamic consequence to current negotiations for the market.

To achieve this, I amend the tractable framework of Segal and Whinston (2007) – hereafter SW – used by them to explore entrant innovation in the context of competitive interactions with an incumbent firm. They only considered competition and the effect of incumbent antitrust practices on rates of innovation.[2] 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 firms in the industry – an incumbent and an entrant.[3] As in SW, an entrant today may become an incumbent tomorrow and vice versa. Unlike SW, 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 role.

In this model, innovations displace completely and immediately the economic value of previous generation products.[4] 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). When

[2] SW did remark upon the possibility of licensing but did not explore it. Other work on cumulative innovation similarly does not endogenise the commercialisation choices of start-ups (see, for example, the survey by Scotchmer, 2004).

[3] 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 firms at any given stage of the dynamic game.

[4] SW allow for a period of temporary competition between an entrant innovator and an incumbent. This possibility is explored in Section 5 below.

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. As will be noted below, this competitive structure is of interest because it is often claimed that in such markets, where static product market competition does not arise, there is a presumption that less antitrust intervention is desirable.

To this end, a key set of parameters in the model considers the *dynamic capabilities* of the firms. SW assumed that, should an incumbent be displaced, then it, with certainty, becomes the entrant for the next generation. This can be interpreted as a strong form of dynamic R&D capabilities whereby a current incumbent has a significant advantage as an innovator towards the next product generation in that it preempts others from contesting the innovation market.

Here I relax this assumption by allowing that incumbent capability to range from non-existent (the incumbent cannot engage in future innovation at all) to strong as assumed by SW. In addition, because my model considers licensing whereby the incumbent is not displaced, I also consider entrant dynamic capabilities. That is, should an entrant license its innovation, there is some probability that it will preempt others in becoming an innovation leader. If this probability is high, the entrant is said to have strong dynamic capabilities. However, a case that will be of interest is where this probability is low and cooperation results in low prospective returns for the entrant from future innovation. It is this possibility that permits the dynamic analysis of notions that licensing or acquisition may involve entrants 'selling their birthright' to future innovative rents. In essence, I 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).

Allowing for innovators to return to the pool of 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 onto 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 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 to become the core of the highly successful OSX. Pixar was acquired by Disney in 2006. Similarly, Walt Disney, having been rebuffed and seen 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 was acquired), Disney was to use his dynamic capabilities to take on established firms in the product market and himself become the market leader.

With this framework I find that some important and subtle, dynamic effects that significantly qualify the intuition of static models of innovation. First, the returns from licensing are driven by immediate savings (avoiding duplication of complementary assets and dissipation of monopoly rents) but also 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.

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 case-based intuition that dynamic capabilities may favor continued competition but also highlights some subtleties in how such capabilities generate this outcome.

A second set of findings concerns the welfare implications of such negotiations. The key driver of welfare in the model here is the probability that a leader innovator will be an entrant. This is because, under Schumpeterian competition, incumbent innovators face muted incentives to accelerate the generation of new product innovations due to Arrow's replacement effect (Arrow, 1962). Hence, it is preferable for innovation leadership to fall on an entrant. As noted earlier, whether a licensing agreement is reached or not drives whether the current incumbent or the entrant innovator becomes a possible future entrant. It is demonstrated below, that under certain circumstances, the negotiating firms prefer to increase the likelihood that one of them is an incumbent innovator (so as to slow down the rate of innovation). Thus, the outcome of negotiations are precisely adverse to the socially desirable outcome. Significantly, this can mean that the firms agree to competition rather than cooperation with socially suboptimal consequences.

Nonetheless, while the welfare consequences of permitting licensing agreements are ambiguous, it is demonstrated that acquisition of the entrant by the incumbent always reduces welfare relative to other options. As noted earlier, many antitrust analysts argue that in markets characterized by Schumpeterian competition, intervention to prevent mergers should be limited as this may involve errors that slow the rate of innovation without additional gains as the market will be monopolized in any case (Evans and Schmalensee, 2002; Katz and Shelanski, 2005). However, it is demonstrated here that, when it occurs, acquisition always results in the lowest probability that there is a future entrant innovator. Consequently, intervention is warranted to ensure that future innovation incentives are correspondingly stronger.

The paper proceeds as follows: in Sections 1 and 2, the basic model is introduced and the equilibrium under no licensing (or competition) is presented. Section 3 then considers the licensing case including a derivation of the licensing fee in a dynamic context. Importantly, this demonstrates that incumbency advantage – even if not forfeited in equilibrium – does impact on innovation benefits in this case and characterizes the gains from trade from licensing. Section 4 then analyses acquisition as opposed to licensing as a form of cooperative commercialization. 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. Highlighting those is a separate contribution of the paper. Section 5 then considers a number of extensions including static product market competition and the impact of research costs. A final section concludes.

1. Model Set-Up

In this section, I describe the basic set-up of the model. It is designed to capture the key elements of a choice between competition and cooperation that captures both static and 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, following a possible brief period of intense competition, the new product replaces the old in a "winner-take-all" manner.

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.[5] This might arise if the innovator has a patent right that, while long-lived, can, because of other consumer choices for related products or workarounds, lead to only a certain level of profit even if the patent rights to one or more generations are controlled by the same entity.[6] This assumption allows us to focus purely on dynamic characteristics.

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 pool of firms (infinite in number) and including the current incumbent that could potentially engage in innovative activity. When it is the current incumbent (*I*), innovation for them allows them to prolong their

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[5] 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.
[6] SW make a similar assumption that once a new product innovation is generated, the previous innovation is placed in the public domain. In Section 5, I relax these assumptions and consider what happens if negotiation leads to the control of two generations of patent rights and price accordingly.

incumbency while a new innovation is developed. If it is any other firm, that firm is termed 'the entrant' or *E*. One can conceptualize this situation as one where ideas for the next product generation occur at random and are granted to only one firm who then invests towards realizing it as a viable innovation. Therefore, for any given firm, the probability that they will engage in innovative entry is infinitesimal. However, as I discuss below, for existing participants in the industry, I consider what happens when they have an advantage in being selected as the innovation leader.[7]

Having been selected as the innovation leader, a firm 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. This simplifies notation because, as will be demonstrated 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.

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).[8] Following this, Nature then decides whether the firm that does not hold patent production rights is selected amongst the pool of firms to become the next entrant.

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[7] Notice that this is a clear departure from the assumption of SW that only two firms in the industry are potential innovators over the entire course of time.

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

If E chooses a *competitive* path, I loses its monopoly profits while E assumes its 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 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.[9] I assume that such negotiations take the Nash bargaining form where the incumbent and entrant both have equal bargaining power.[10] If a licensing deal is successfully negotiated, E receives a once-off payment, τ, while I preserves its monopoly position. In this situation, it is E who returns to the pool of firms as a potential future entrant while I has a chance of becoming the innovation leader as an incumbent.

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 both for 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 they are not. As noted earlier, for most models of patent races and innovation, displaced incumbents exit the industry while for SW a displaced incumbent merely forgoes technological leadership; taking on the role of the entrant.

Here I nest both of these possibilities. Recall that, following successful entrant innovation, the next innovation leader is selected from an infinite pool of firms; including the

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[9] It is implicitly assumed that if E were to engage in non-exclusive licensing, then the resulting on-going 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.

[10] 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.

displaced incumbent, in the case of competition, or the entrant, in the case of cooperation. That is, it is assumed that the 'know-how' of how to progress towards the next product innovation is acquired by a single firm who can then exploit it by engaging in research towards that next generation product. However, there are distinct reasons why different types of firms might have a greater chance of being selected from that pool; that is, an advantage in future innovative competition.

For a previous incumbent who is not an innovation leader, knowledge and experience of the industry may afford them with 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 upon whether cooperative commercialization occurs or not. Otherwise, they (effectively) exit the industry and another firm takes on the role of the entrant.[11]

For an entrant who pursues cooperative commercialization, their future innovative advantage may arise because of their knowledge of the innovative process for this line of products. To capture this, I assume that an entrant who 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, they exit and are, potentially, 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.

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[11] This the impact to leveraging production experience (and as will be seen innovator experience) lasts only to the next generation and depreciates completely beyond that.

Finally, the previous incumbent might also be an innovation leader. In this case, they combine the knowledge from production and innovation and this translates into a probability, $\sigma_{ip} \in [0,1]$ that they 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.

One interpretation of these parameters is that a firm is likely to transition between product generations if it has a dynamic innovative capability. 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)[12] Nonetheless, this is a 'high level' analysis in that I do not explore the sources of such capabilities nor take a view on how they are maintained (cf: Sutton, 2002).[13]

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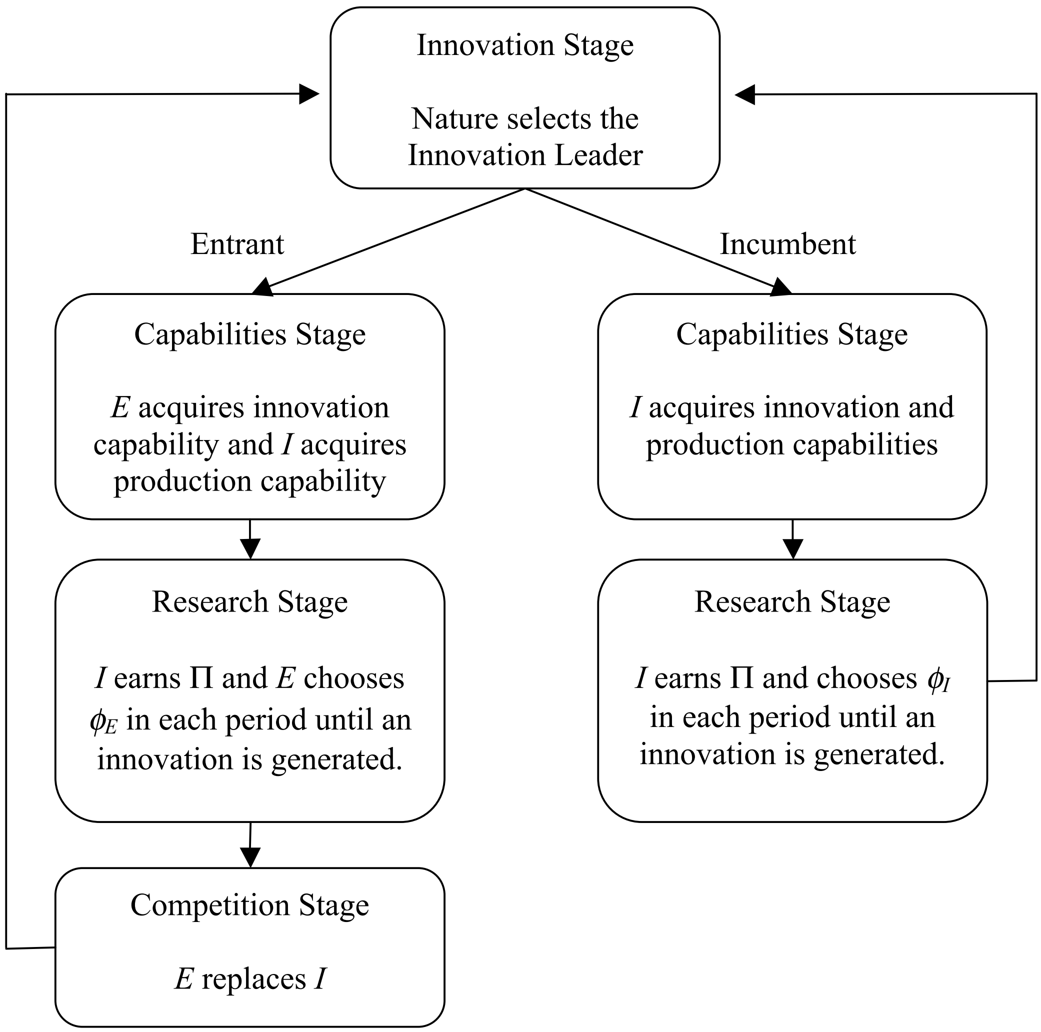
[12] Those capabilities may come externally – through entry. Alternatively, they might be developed internally by those who are currently innovating towards the next product generation. In this respect, a firm is said to have a dynamic capability if they are able to successfully engage in development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

[13] It also does not take into account that the capability itself may be a function of commercialization choices (e.g., that licensing might give a start-up cash to finance the next innovation generation).

2. Competition for the Market

I begin with the case where negotiation for the market (i.e., a licensing deal, patent sale or acquisition) is not possible. Figure One depicts the timing in this case.

Figure One: Competition



In the infinite-horizon dynamic game, as in SW, I confine attention to stationary Markov perfect equilibria. For this purpose, let V_I be the expected present value of profits of a non-innovating incumbent firm at the beginning of any given period, V_I^i those for an innovating incumbent and V_E those of an innovating entrant. These values will satisfy:

$$V_E = (1-\phi_E)\delta V_E + \phi_E(\Pi + \sigma_i \delta V_I^i + (1-\sigma_i)\delta V_I) \tag{VE}$$

$$V_I = (1-\phi_E)(\Pi + \delta V_I) + \phi_E \sigma_p \delta V_E \tag{VI}$$

$$V_I^i = (1-\phi_I)(\Pi + \delta V_I^i) + \phi_I(\Pi + \sigma_{ip}\delta V_I^i + (1-\sigma_{ip})\delta V_I) \tag{VI-i}$$

Note that, following an entrant innovation, the entrant continues in the industry by default (as the incumbent) while the incumbent may only with probability σ_p continue in the industry as an innovating entrant. In addition, with probability σ_i the new incumbent becomes an innovating one. If an incumbent generated the innovation, with probability σ_{ip} it continues as the innovator for the next generation.

Both an incumbent innovator and an entrant innovator can, if placed in those roles, choose the rate of innovation in each period. Recall that the choice of research rate is an element $[\phi,1]$ and there are no costs to increasing that rate. Therefore, an innovator will choose ϕ or 1 depending upon whether the returns to innovating are positive or not. For an entrant, a positive level of innovation will be chosen if:

$$\Pi + \sigma_i \delta V_I^i + (1-\sigma_i)\delta V_I \geq \delta V_E \tag{1}$$

that is, if the value from successfully innovating in the next period exceeds the loss in continuation profits when an innovation occurs. For an incumbent innovator, the per period return to innovation is positive if:

$$(1-\sigma_{ip})\delta(V_I - V_I^i) \geq 0 \tag{2}$$

That is, if the incumbent innovator prefers not to be an innovator in which case it would want to slow down the likelihood of that occurring. It is concerned about its own replacement or cannibalization of existing products (Arrow, 1962; Reinganum, 1989). As is demonstrated in the following proposition, the incumbent never wants to accelerate research while, for the entrant, the returns to innovation are always positive.

Proposition 1. *The unique Markov perfect equilibrium involves* $\hat{\phi}_I = \phi$ *and* $\hat{\phi}_E = 1$ *resulting in continuation values of:*

$$V_E = \tfrac{1}{\Delta_c}\Pi\left(1-\delta(1-\phi)+\delta(\sigma_i-\phi\sigma_{ip})\right)$$
$$V_I = \tfrac{1}{\Delta_c}\delta\Pi\left(1-\delta(1-\phi)+\delta(\sigma_i-\phi\sigma_{ip})\right)\sigma_p$$
$$V_I^i = \tfrac{1}{\Delta_c}\Pi\left(1-\delta^2\left(1-\phi(1-\sigma_{ip})-\sigma_i\right)\sigma_p\right)$$

where $\Delta_c = 1-\delta(1-\phi)-\delta(\phi\sigma_{ip}+\delta((1-\delta(1-\sigma_i)+\delta\phi(1-\sigma_{ip}))\sigma_p)$.

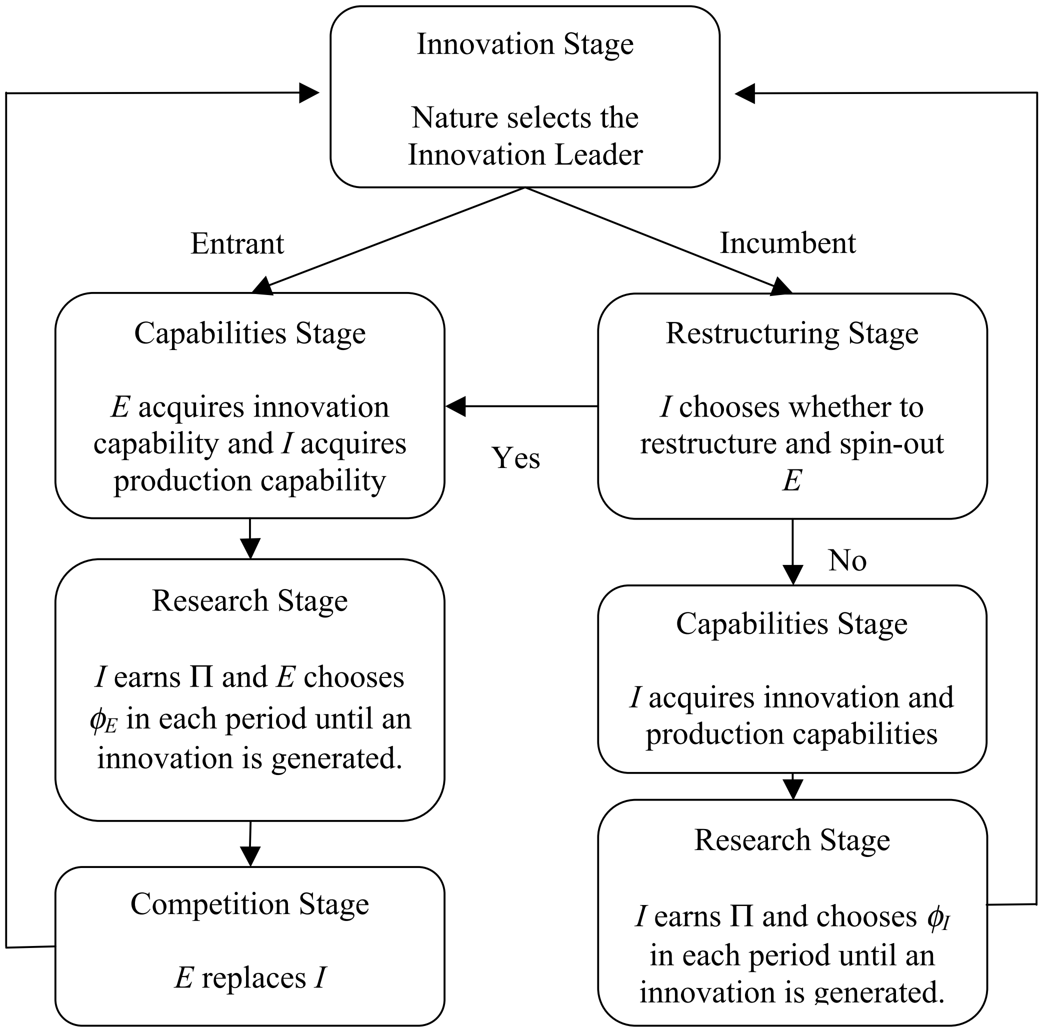
The proof of the proposition is straightforward (solving for (VE), (VI) and (VI-i) simultaneously under the conjectured equilibrium conditions and verifying that (1) is positive and (2) is negative under those conditions and that this does not change for other choices of the innovation rate for the incumbent and entrant). The main usefulness of Proposition 1 will be to prove under what conditions competition for the market remains an equilibrium when cooperative deals are possible.

Restructuring and spin-outs

In the model thusfar, the only way for an incumbent innovator to emerge is for an entrant innovator to become the lead innovator for the next generation. However, at the point at which that firm acquires the know-how to research towards the next generation product, it could choose 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 its incumbent producer.[14] Figure Two depicts the timing of the model with this option included.

[14] It is assumed that the incumbent producer in this case does not innovate at all in competition with the spun out entrant.

Figure Two: Competition & Restructuring



A potential incumbent innovator leader will only choose to restructure if $V_I^i < V_I + V_E$. Observe that:

$$V_I^i \geq V_I + V_E \Rightarrow 1 - \phi(1 - \sigma_{ip}) \geq \sigma_i + \sigma_p \tag{3}$$

What this says is that a restructure may be optimal if ϕ is high (implying that there is little power to use incumbency to slow down the rate of innovation) and $\sigma_i + \sigma_p$ is high relative to σ_{ip} (indeed (3) collapses to $\sigma_{ip} \geq \sigma_i + \sigma_p$ as ϕ approaches 1). Thus, if (3) does not hold, a potential incumbent innovation leader prefers to divest and set up an innovating firm that will eventually displace itself.[15]

Of course, a restructure would change the equilibrium payoffs of the incumbent and entrant. Specifically, suppose that $1-\phi(1-\sigma_{ip})<\sigma_i+\sigma_p$. Then an incumbent innovator never emerges and (VE) becomes:

$$V_E=(1-\phi_E)\delta V_E+\phi_E(\Pi+\sigma_i\delta(V_E+V_I)+(1-\sigma_i)\delta V_I) \quad \text{(VE)}$$

while (VI) and (VI-i) remain unchanged. In equilibrium, it is still the case that $\hat{\phi}_I=\phi$ and $\hat{\phi}_E=1$ with equilibrium payoffs of:

$$V_E=\frac{\Pi}{1-\delta(\sigma_i+\delta\sigma_p)} \quad (4)$$

$$V_E=\frac{\delta\sigma_p\Pi}{1-\delta(\sigma_i+\delta\sigma_p)} \quad (5)$$

It is straightforward to show that when $1-\phi(1-\sigma_{ip})<\sigma_i+\sigma_p$, no potential incumbent innovator wants to deviate for one generation to become an actual incumbent innovator rather than restructure. As will be shown below, this condition plays an important role in the incentive and welfare effects of licensing.

It is useful to note here that given that $\hat{\phi}_E>\hat{\phi}_I$, spin-outs are always socially desirable as they create an entrant innovator rather than an incumbent one. However, as is demonstrated here, spin-outs do not necessarily arise. The under-provision of spin-outs from a social

[15] There is an issue of whether a restructure is possible. However, as the main point of this paper is to examine situations whereby licensing or other cooperative arrangements could allow the production rights for an innovation to be transferred and separated from a firm who might innovate for the next generation, considering the option to unilaterally restructure is consistent with the option to negotiate a restructure. Indeed, it is arguably easier to achieve.

perspective is a common finding in the literature.[16]

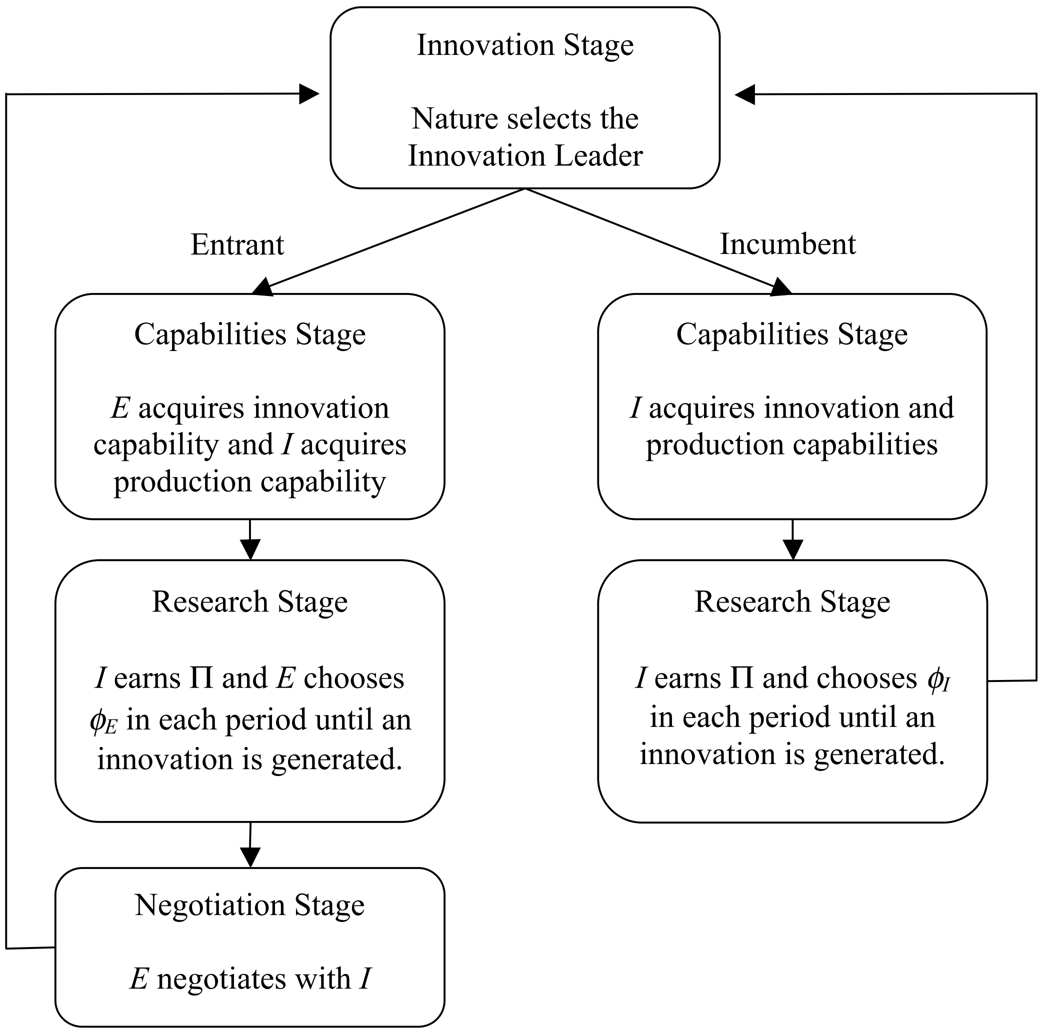
3. Licensing and Negotiation

The previous section provides a model that requires firms to compete for the market. In this section, firms are given the option of negotiating for that market with entrant innovators being able to license their patent to the incumbent.[17] Figure Three depicts the new timing where the competition stage in Figure One has been replaced by a negotiation stage in which the entrant and incumbent decide whether to license or not and what the license fee, τ, will be if they come to an agreement. It is assumed, initially, that potential incumbent innovators cannot choose to restructure with a spin-out. This possibility is explored later in the section.

In the negotiation stage with the entrant, if they agree to license, the incumbent earns $\Pi - \tau + \sigma_p \delta V_I^i + (1-\sigma_p)\delta V_I$ from licensing for a fee of τ but otherwise expects to earn $\sigma_p \delta V_E$ (as entry occurs and incumbency is foregone). The innovator expects to earn $\tau + \sigma_i \delta V_E$ from licensing (as it may not persist in the industry) and $\Pi + \sigma_i \delta V_I^i + (1-\sigma_i)\delta V_I$ otherwise (as it gains, with certainty, an incumbency advantage from entry).

[16] For example, Hellmann (2007) demonstrates how firm intellectual property policy impacts on the rate at which spin-outs occurs. See also Anton and Yao (1995) and Cassiman and Ueda (2007).
[17] In theory, an incumbent innovator could license to an entrant (Frantzeskakis and Ueda, 2008) but it is easy to show that there are no gains to trade from this as the entrant has no dynamic capability whereas the incumbent does. The case of acquisition as opposed to licensing will be considered in the next section.

Figure Three: Licensing



There will be gains to trade through licensing, and hence, agreement, if:

$$\underbrace{\Pi - \tau + \sigma_p \delta V_I^i + (1-\sigma_p)\delta V_I + \tau + \sigma_i \delta V_E}_{\text{Joint Payoff from Cooperation}} \geq \underbrace{\sigma_p \delta V_E + \Pi + \sigma_i \delta V_I^i + (1-\sigma_i)\delta V_I}_{\text{Joint Payof from Competition}} \tag{6}$$
$$\Rightarrow (\sigma_p - \sigma_i)\delta\left(V_I^i - V_E - V_I\right) \geq 0$$

where it is assumed that if firms are indifferent between licensing or not they choose to license. In a static sense, a licensing 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 as 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 $\sigma_p(V_I^i - V_I) + \sigma_i V_E$ whereas if they do not, these expected joint profits become $\sigma_i(V_I^i - V_I) + \sigma_p V_E$. Thus, whether this future profits component drives licensing depends upon whether $V_I^i - V_I > V_E$ (that is, expected joint returns are maximized with an incumbent innovator (V_I^i) than with an entrant innovator ($V_E + V_I$)) 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 to assign roles that maximize expected future joint profits.

To fully characterize the possible outcomes, we need to solve for the continuation values. In the licensing case, the (conjectured) equilibrium continuation payoffs are:

$$V_I = \Pi + (1-\phi_E)\delta V_I + \phi_E(-\tau + \sigma_p \delta V_I^i) \quad \text{(VI)'}$$

$$V_E = (1-\phi_E)\delta V_E + \phi_E(\tau + \sigma_i \delta V_E) \quad \text{(VE)'}$$

while the equation for V_I^i remains as in the competition case (VI-i). Notice that, along the (conjectured) equilibrium path, incumbency involves a continual flow of monopoly profits (Π) peppered by the payment of license fees to preserve technological (and market) leadership. In contrast, potential entrant returns are governed by the periodic earnings from license fees if they happen to become an innovation leader.

Determining the conditions under which licensing will actually take place in equilibrium involves deriving the continuation values themselves which itself requires a solution for τ. Given this, I employ the Nash bargaining solution to determine the license fee. Assuming for the moment, that the gains from trade are positive, let $\gamma \in [0,1]$ denote the bargaining power of the entrant. Then the license fee, τ, is found by solving:

$$\max_{\tau} \left(\Pi - \tau + \sigma_p \delta V_I^i + (1-\sigma_p)\delta V_I - \sigma_p \delta V_E\right)^{1-\gamma} \left(\tau + \sigma_i \delta V_E - (\Pi + \sigma_i \delta V_I^i + (1-\sigma_i)\delta V_I)\right)^{\gamma} \tag{7}$$

This gives $\tau = \Pi + \delta V_I(1-(1-\gamma)\sigma_i - \gamma\sigma_p) + \delta(V_I^i - V_E)((1-\gamma)\sigma_i + \gamma\sigma_p)$. Using this, the following proposition can be proved.

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

$$\tfrac{\delta^2\Pi}{\Delta_l}(\sigma_p - \sigma_i)\left(1-\phi(1-\sigma_{ip}) - \sigma_i - \sigma_p\right) \geq 0$$

where $\Delta_l = 1 - \delta\left(\left(1-\phi(1-\sigma_{ip})\right)\left(1-\delta\left(\left(\gamma + (1-\gamma)\delta\right)\sigma_i - \gamma(1-\delta)\sigma_p\right)\right) + \sigma_i\left(1-(1-\gamma)\delta(1-\delta)\sigma_i\right) - (1-\delta)\sigma_p(1-\sigma_p)\right)$. *Otherwise, competition is the unique Markov perfect equilibrium. If it exists, the licensing equilibrium involves* $\hat{\phi}_I = \phi$ *and* $\hat{\phi}_E = 1$ *resulting in continuation values of:*

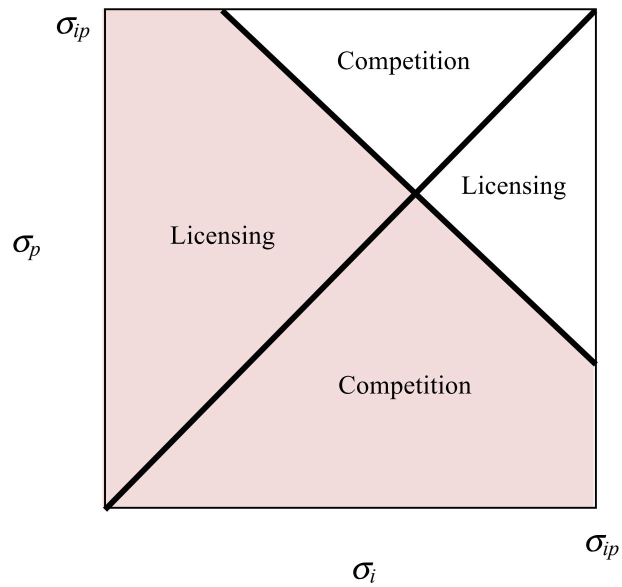
$$V_E = \tfrac{1}{\Delta_l}\Pi\left(1-\delta(1-\phi) - \delta(\phi\sigma_{ip} - \sigma_p)\right)$$

$$V_I = \tfrac{1}{\Delta_l}\delta\Pi\left(\sigma_p(1+\delta\gamma\sigma_p) - \delta((\phi - \sigma_i)(1-\gamma)\sigma_i) - \delta\left((1-\gamma)\sigma_i + \gamma\sigma_p\right)(1-\phi(1-\sigma_{ip}))\right)$$

$$V_I^i = \tfrac{1}{\Delta_l}\Pi\left(1-\delta\left(\sigma_i\left(1+(1-\gamma)\delta\left(1-\phi(1-\sigma_{ip}) - \sigma_i\right)\right) - \sigma_p\left(1-\gamma\delta\left(1-\phi(1-\sigma_{ip}) - \sigma_p\right)\right)\right)\right)$$

The proof of the proposition proceeds along the same lines as Proposition 1 with the additional step of verifying whether or not there are positive gains from trade both from the conjectured licensing equilibrium and possible competition equilibrium. The gains from trade from licensing are positive if and only if $(\sigma_p - \sigma_i)\left(1-\phi(1-\sigma_{ip}) - \sigma_i - \sigma_p\right) \geq 0$. Figure Four depicts the equilibrium outcomes in (σ_i, σ_p) space where, for convenience, it is assumed that $\sigma_{ip} \leq \frac{1}{2}$.[18]

Figure Four: Licensing Equilibrium Outcomes



Intuitively, the proposition demonstrates that, regardless of whether licensing occurs in equilibrium or not, $V_I^i \geq V_I + V_E$ if and only if $1-\phi(1-\sigma_{ip}) \geq \sigma_i + \sigma_p$. Recall that this is the same condition that drove whether a potential incumbent innovator chose to restructure into a separate incumbent producer and entrant innovator in the competition case above. Specifically, if $V_I^i \geq V_I + V_E$, 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

[18] 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.

lead innovator in the next generation. Jointly, the firms want that lead innovator to be the incumbent and so to achieve that they do not license and the current entrant displaces the current incumbent as a producer. Interestingly, the end result is competition, precisely to ensure the entrant has the muted research incentives of an incumbent producer.

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 who forgoes licensing has a good chance of becoming an incumbent who is the innovation leader.

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 but in a way to ensure that it does not research too intensively (something it will not do if it is an incumbent).

Nonetheless, even when $\sigma_i > \sigma_p$, it may be that $V_I^i < V_I + V_E$. If a restructure is not possible for potential incumbent innovators, the firms will agree to license to ensure that the current incumbent's position is preserved and the chance that an incumbent innovator emerges is minimized. 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 putting the current entrant in an incumbent producer position. Consequently, they choose not to license in order to achieve this outcome.

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

Welfare

We are now in a position to consider the welfare consequences of licensing. Note that welfare is maximized when there is an entrant rather than an incumbent is innovating as $\hat{\phi}_E > \hat{\phi}_I$ regardless of whether there is competition or licensing. Thus, if experience drives who is likely to become the innovation leader, welfare is maximized by ensuring that the firm with the highest dynamic capability remains or becomes an entrant.

When choosing whether to license or not, licensing ensures the current entrant will, if they become the innovation leader, be an entrant innovator. This is a socially desirable outcome if $\sigma_i > \sigma_p$. Otherwise, if $\sigma_p > \sigma_i$, it is preferable to ensure the current incumbent is displaced so that, if it becomes the innovation leader, it is an entrant position (and unconcerned about cannibalization of incumbency rents). In this situation, licensing is not socially desired.

Proposition 2 demonstrates, however, that social and private incentives for licensing are only aligned if $V_I^i < V_I + V_E$. Otherwise, *firms license when it is socially undesirable and choose not to license when it would be socially desirable*. This is because, when $V_I^i > V_I + V_E$, the firms want to maximize the probability that one of them is an incumbent innovator rather than the probability that one of them is an entrant innovator. (Figure Four depicts when equilibrium outcomes are socially sub-optimal; the red shaded area. Otherwise, they are socially optimal.)

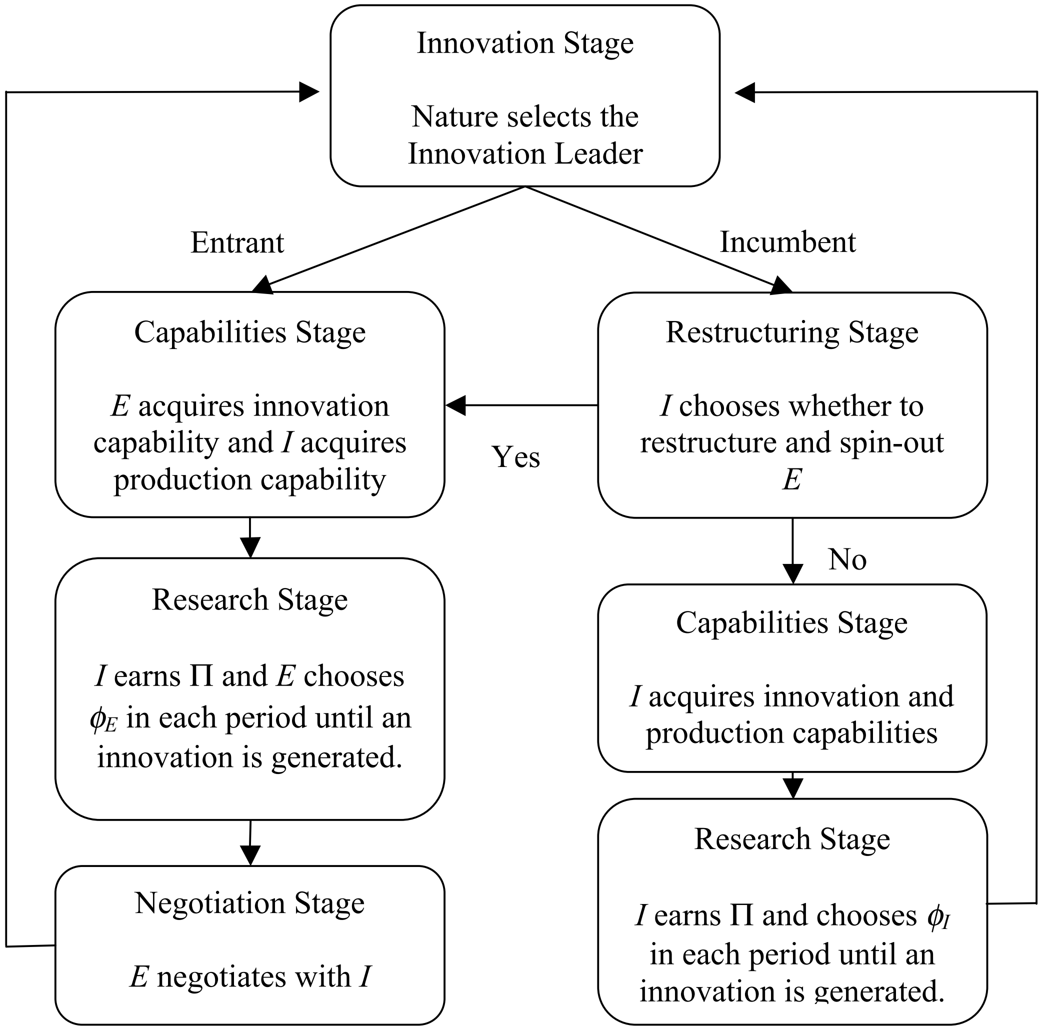
The complete discord between private and social licensing incentives is interesting because usually concerns about licensing give rise to policy prescriptions banning such licensing. However, here it may be that the private incentives to license are low relative to the social benefits of such licensing. Consequently, we cannot say whether prohibiting licensing will improve welfare or not.

It is important to note that the model here, by assuming that research occurs without cost, decouples entrant research intensity from potential rents. In this way, the entrant chooses the highest possible research intensity in order to get rents sooner. If there were research costs, the solution may be interior (as in SW). In this case, an unregulated choice over licensing (that is, neither prohibiting it or requiring it) always increases the rents associated with innovation and so would be expected to lead to a higher entrant research intensity than if licensing were not allowed.

Restructuring

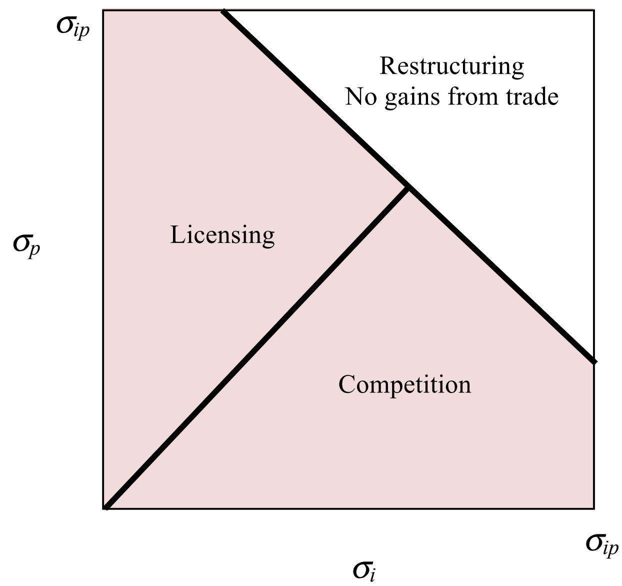
We now turn to consider what happens when it is possible a potential incumbent innovator to restructure prior to the capabilities stage beginning; see Figure Five. Note that when $V_I^i \geq V_I + V_E$, an incumbent will not exercise this option. In this case, $1-\phi(1-\sigma_{ip}) \geq \sigma_i + \sigma_p$ and whether licensing occurs depends upon whether $\sigma_p > \sigma_i$ or not (see Figure Six).

Figure Five: Licensing & Restructuring



However, if, in the absence of a restructure, $V_I^i < V_I + V_E$, such restructuring will be chosen in equilibrium. In effect, this means that $V_I^i = V_I + V_E$ and an examination of (6) shows that there will be no gains to licensing. Consequently, the alignment of private and social incentives to license that would have otherwise arisen when $1-\phi(1-\sigma_{ip}) < \sigma_i + \sigma_p$ would no longer hold (see Figure Six).[19] That said, the social inefficiencies noted with respect to the restructuring decision under competition continue to apply here; namely, there is too little restructuring.

Figure Six: Licensing & Restructuring



4. Cooperation by 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 or shift in intellectual property rights is infeasible or in preference to those agreements. Both licensing and acquisition share in common the outcome that an agreement means that the current incumbent retains its incumbency. The difference between them is what happens to the entrant. While, under licensing, the entrant returns to the pool of potential entrant innovation leaders, under acquisition, it is removed as a potential

[19] If there were static gains to licensing (to eliminate short-term competition or save on the duplication of complementary assets), licensing may still occur in this case. However, its social desirability would hinge on a number of factors and the discord between private and social incentives will still arise.

independent innovator. Instead, the entrant innovator's capabilities are added to those of the incumbent. Consequently, it 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. Here, I consider when acquisition might be an equilibrium outcome relative to competition and also relative to licensing.

The timing of the acquisition game is identical to Figures Three and Four except that in the negotiation stage, *E* is negotiating with *I* over an acquisition. For the moment, it will be assumed that there is no restructuring option and that licensing is not possible. The implications of relaxing these restrictions will be explored below.

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

$$\begin{aligned}&\underbrace{\Pi-\tau+\sigma_{ip}\delta V_I^i+(1-\sigma_{ip})\delta V_I+\tau}_{\text{Joint Payoff from Cooperation}} \geq \underbrace{\sigma_p\delta V_E+\Pi+\sigma_i\delta V_I^i+(1-\sigma_i)\delta V_I}_{\text{Joint Payof from Competition}}\\&\Rightarrow(\sigma_{ip}-\sigma_i)\delta(V_I^i-V_I)\geq\sigma_p\delta V_E\end{aligned} \quad (8)$$

This highlights the difference between the gains from trade from acquisition as opposed to licensing (6). First, acquisition improves the ability of both firms to together earn V_I^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 retire resources with certain capabilities, 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 which is internalized if no acquisition takes place.[20]

As for the equilibrium payoffs in the acquisition case, we have:

$$V_I = \Pi + (1-\phi_E)\delta V_I + \phi_E(-\tau + \sigma_{ip}\delta V_I^i) \quad \text{(VI)''}$$

$$V_E = (1-\phi_E)\delta V_E + \phi_E\tau \quad \text{(VE)''}$$

where, V_I^i is still determined according to (VI-i). Using, the Nash bargaining solution, τ is given by: $\tau = \Pi + \delta V_I - \sigma_p \gamma \delta V_E + \delta(\sigma_i(1-\gamma) + \sigma_{ip}\gamma)(V_I^i - V_I)$. Using this, the following proposition can be proved.

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

$$\tfrac{\delta\Pi}{\Delta_a}\left(\sigma_{ip} - \sigma_i - \sigma_p\left(1-\delta(1-\phi)(1-\sigma_{ip})\right)\right) \geq 0$$

where $\Delta_a = 1-\delta\left(1-\phi+(1-\gamma)(1-\delta)\sigma_i - (1-\delta-\phi)\sigma_{ip} + (1-\phi)\gamma(1-\delta)\delta(1-\sigma_{ip})\sigma_p\right)$. *Otherwise, competition is the unique Markov perfect equilibrium. If it exists, the acquisition equilibrium involves* $\hat{\phi}_I = \phi$ *and* $\hat{\phi}_E = 1$ *resulting in continuation values of:*

$$V_E = \tfrac{1}{\Delta_a}\Pi\left(1-\delta(1-\phi)(1-\sigma_{ip})\right)$$

$$V_I = \tfrac{1}{\Delta_a}\delta\Pi\left(\sigma_{ip} - (1-\gamma)\sigma_i - \gamma\delta(1-\phi)(1-\sigma_{ip})\sigma_p\right)$$

$$V_I^i = \tfrac{1}{\Delta_a}\Pi\left(1-\delta\left((1-\gamma)\sigma_i - \sigma_{ip} + \gamma\delta(1-\phi)(1-\sigma_{ip})\sigma_p\right)\right)$$

The proof of the proposition proceeds along the same lines as previous propositions. Figure Seven depicts the equilibrium outcomes. Significantly, the gains from trade from acquisition are positive if and only if $\sigma_{ip} - \sigma_i \geq \sigma_p\left(1-\delta(1-\phi)(1-\sigma_{ip})\right)$. Notice that this always holds 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 monopoly profits for longer.

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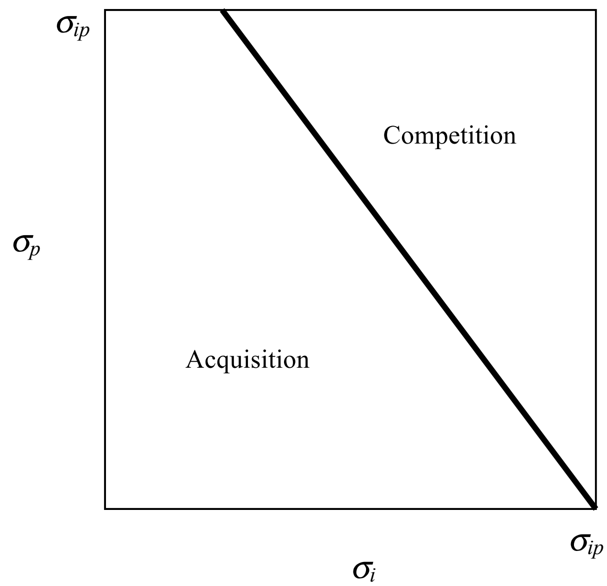
[20] Note that if the 'principle of selective intervention' applied then it could not be the case that $\sigma_{ip} < \sigma_i + \sigma_p$. However, as noted earlier, it may be that to take advantage of this would require restructuring. In its absence, a firm might still choose to integrate its capabilities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

Figure Seven: Acquisition Equilibrium Outcomes



However, it is also possible that this holds even if $\sigma_{ip} < \sigma_i + \sigma_p$ so long as ϕ is sufficiently low. This is because, even though acquisition increases the probability that an entrant will become the innovation leader, as $\sigma_{ip} \geq \sigma_i$, the probability that the previous entrant becomes an incumbent innovation leader is higher and the value of that incumbency is similarly high. In contrast, when ϕ is relatively high, the value of incumbency is low and the parties decide not to proceed with an acquisition in order to deny a positive externality on potential entrants.

Welfare

From a welfare standpoint, recall that the goal is to maximize the probability that there is an entrant innovator. If an acquisition proceeds, that probability is $1-\sigma_{ip}$ but if competition occurs it is $1-\sigma_i$. Thus, the acquisition is socially desirable if $\sigma_{ip} < \sigma_i$; which cannot hold by the assumption of free disposal. Thus, acquisition is never socially desirable relative to competition.

This result is significant because it takes place in an environment of Schumpeterian competition that is often believed to reduce concerns about mergers. Katz and Shelanski concluded based on their examination of antitrust practice that:

> [t]he nature of Schumpeterian competition suggests to some observers that antitrust policy should be less concerned with attacking business practices that might generate increased monopoly profits by harming competition within a market or should at least be more circumspect about doing so. … Proponents of the view that government intervention should be limited in this type of market generally argue that merger policy is likely to make costly errors through enforcement that will have the unintended effect of slowing innovation. As the argument goes, in dynamic markets, it is impossible to predict what will happen, current market positions are irrelevant to future competition, and at any point the market will be monopolized anyway. (Katz and Shelanski, 2005, p.140)

The basis for that is that the usual concerns about mergers – namely the creation of market power in product markets – does not hold when the industry is characterized by successive monopolies (Evans and Schmalensee, 2002). It is also distinct from related concerns about what mergers might do to the intensity of R&D competition (Katz and Shelanski, 2005) as this has been assumed away here.

Instead, the model here argues that acquisitions will be motivated by the desire to ensure that highly motivated entrant innovators do not emerge to cannibalize existing incumbent profits. A merger between the incumbent and entrant removes the entrant's experience as an innovator from becoming an entrant innovation leader. Thus, even though this does not block other potential entrants per se, it ensures that the capabilities to do so are consolidated. Thus, the merger changes the set of firms with the potential to become, not only the next temporary monopolist, but to research intensively to that end. And it is precisely the nature of Schumpeterian competition that drives the firms to merge to delay the forces of creative destruction.

Comparing Licensing and Acquisition

Of course, in reality, firms may have options of choosing between licensing and acquisition as a mode of cooperative commercialization. Comparing (6) and (8), acquisition will have higher gains from trade than licensing if:

$$\begin{aligned}&\sigma_p\delta V_E-(\sigma_{ip}-\sigma_i)\delta(V_I^i-V_I)\geq\left(\sigma_i-\sigma_p\right)\delta\left(V_I^i-V_E-V_I\right)\\&\Rightarrow(\sigma_{ip}-\sigma_p)(V_I^i-V_I)\geq\sigma_iV_E\end{aligned}\tag{9}$$

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 continuation values from Proposition 3 (or Proposition 2 for that matter) into (9) implies that (9) will hold if and only if:

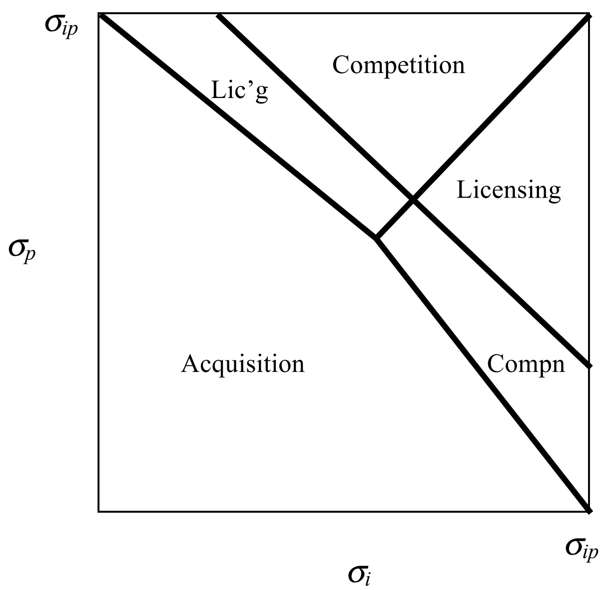
$$\sigma_{ip}-\sigma_p\geq\sigma_i\left(1-\delta(1-\phi)(1-\sigma_{ip})\right)\tag{10}$$

Notice that acquisition is preferred to licensing if $\sigma_{ip}\geq\sigma_i+\sigma_p$. This is because acquisition has the additional impact of reducing the probability that third parties become the innovation leader. In addition, observe that when acquisition is an equilibrium licensing is only preferred if $\sigma_{ip}-\sigma_i\geq\sigma_p\left(1-\delta(1-\phi)(1-\sigma_{ip})\right)$. This requires that the following is possible.

$$\begin{aligned}&\sigma_i\left(1-\delta(1-\phi)(1-\sigma_{ip})\right)+\sigma_p\geq\sigma_p\left(1-\delta(1-\phi)(1-\sigma_{ip})\right)+\sigma_i\\&\Rightarrow(\sigma_i-\sigma_p)\left(-\delta(1-\phi)(1-\sigma_{ip})\right)\geq0\Rightarrow\sigma_i\leq\sigma_p\end{aligned}\tag{11}$$

Thus, if $\sigma_i>\sigma_p$, licensing is not chosen over acquisition when acquisition is an equilibrium. Figure Eight depicts the equilibrium outcomes.

Figure Eight: Acquisition versus Licensing



When both licensing and acquisition are available options, this, generally, results in improved welfare outcomes relative to the acquisition-only case. In particular, licensing sometimes displaces acquisition causing a direct welfare gain but the introduction of licensing can also displace competition the results of which are ambiguous.

Restructuring

We now turn to consider what happens when a potential incumbent innovator is able to restructure prior to acquiring capabilities. As before, the incentive to do this will depend upon whether $V_I^i < V_I + V_E$ or not. Substituting in the values from Proposition 3, notice that $V_I^i - V_I - V_E = \frac{\delta\Pi}{\Delta_a}(1-\phi)(1-\sigma_{ip})$. Consequently, whenever acquisition is an equilibrium, restructuring is not chosen.

5. Extensions

Here several possible extensions to the model presented thusfar are discussed.

R&D costs

If there were costs associated with increasing research intensity from ϕ to 1, then while an incumbent innovator would still choose $\hat{\phi}_I = \phi$ and entrant innovator may choose the same level of research intensity as the incumbent if those costs are sufficiently high. In this case, the main drivers of whether licensing, acquisition or competition arises would still hold. Specifically, if $\hat{\phi}_I = \hat{\phi}_E = \phi$, then, licensing will be observed over competition if $(\sigma_p - \sigma_i)(\sigma_{ip} - \sigma_p - \sigma_i) \geq 0$, acquisition will be observed over competition and licensing if $\sigma_{ip} - \sigma_p - \sigma_i \geq 0$. Thus, while the ability to use negotiation to increase the likelihood that there is an incumbent innovator who researches less intensively is removed, the same relative parameters drive whether a negotiated outcome is reached and what type of outcome it is.

The interesting issue is what happens when there is a difference between the research intensity of the entrant chosen under competition as opposed to licensing. It is easy to see that where licensing (competition) is an equilibrium, entrant research intensity would not rise and may fall if licensing were prohibited (made compulsory). In this case, the welfare effects of such policies would depend upon the degree to which research intensity might fall and a comparison with the probability that there is an entrant innovator. Specifically, if research intensity did not fall by much, the considerations discussed above would continue to hold while if it fell be large amount, the welfare conclusions drawn previously may be reversed. Nonetheless, the main point that because licensing does not necessarily involve positive gains from trade means that a prohibition on licensing may not improve social welfare as competition may not yield a faster rate of innovation continues would hold even if R&D costs were introduced.

That said, the model cannot be generalized in a straightforward way by the addition of R&D costs and so a full exploration of that is left to future research. The reason is that there may be multiple equilibria (e.g., one with licensing and one with competition for the same parameter values) or a mixed equilibrium (i.e., where negotiating parties play a mix strategy of agreeing and disagreeing to licensing deals).

Product market competition

In SW, innovation and entry by an entrant innovator leads to a single period of product market competition. To capture this here suppose that during that period of competition, the entrant, with its superior product, could earn a fraction, α, if monopoly profits while the displaced incumbent would earn 0. Following that period, as in SW, the entrant can earn monopoly profits for as long as it remains the incumbent.

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

$$V_E = (1-\phi_E)\delta V_E + \phi_E(\alpha\Pi + \sigma_i \delta V_I^i + (1-\sigma_i)\delta V_I)$$

Second, the gains from trade from licensing (6) becomes:

$$\begin{aligned}&\underbrace{\Pi - \tau + \sigma_p \delta V_I^i + (1-\sigma_p)\delta V_I + \tau + \sigma_i \delta V_E}_{\text{Joint Payoff from Cooperation}} \geq \underbrace{\sigma_p \delta V_E + \alpha\Pi + \sigma_i \delta V_I^i + (1-\sigma_i)\delta V_I}_{\text{Joint Payof from Competition}} \\ &\Rightarrow (1-\alpha)\Pi + (\sigma_p - \sigma_i)\delta\left(V_I^i - V_E - V_I\right) \geq 0\end{aligned} \quad (12)$$

This will also change the negotiated licensing fee to take into account the additional static benefit relative to competition of $(1-\alpha)\Pi$. Recalculating the equilibrium continuation payoffs, licensing is an equilibrium if and only if:

$$(1-\alpha)\Pi + \tfrac{\delta^2}{\Delta_I}\Pi\left(\gamma + \alpha(1-\gamma)(1-\delta) + \delta(1-\gamma)\right)(\sigma_p - \sigma_i)\left(1 - \phi(1-\sigma_{ip}) - \sigma_i - \sigma_p\right) \geq 0 \quad (13)$$

Observe that these gains now include the static benefits from licensing in terms of reduced product market competition as well as a dynamic component, the sign of which is driven by the same parameters as the model without product market competition.

This increases the range of parameters where 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, (13) becomes:

$$\begin{aligned}&(1-\alpha)\Pi+\Pi\frac{(\sigma_p-\sigma_i)(1-\phi(1-\sigma_{ip})-\sigma_i-\sigma_p)}{\phi(1-\sigma_i)(1-\sigma_{ip})}\geq 0\\&\Rightarrow(1-\alpha)\phi(1-\sigma_i)(1-\sigma_{ip})\geq(\sigma_i-\sigma_p)(1-\phi(1-\sigma_{ip})-\sigma_i-\sigma_p)\end{aligned} \tag{14}$$

Now suppose that $\sigma_{ip},\sigma_p\to 1$, then (14) becomes:

$$0\geq\sigma_i(1-\sigma_i) \tag{15}$$

which never holds. 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 (14) becomes:

$$0\geq-\sigma_p(1-\sigma_p) \tag{16}$$

which always holds. This means that competition, as an equilibrium, when there is potential product market competition, is preserved when $\sigma_p \gg \sigma_i$ but not for the reverse unless ϕ is very small.

For acquisition, this is an equilibrium if and only if:

$$(1-\alpha)\Pi+\tfrac{\delta}{\Delta_a}\Pi\left(\gamma+\alpha(1-\gamma)(1-\delta)+\delta(1-\gamma)\right)\Big(\sigma_{ip}-\sigma_i-\sigma_p\left(1-\delta(1-\phi)(1-\sigma_{ip})\right)\Big)\geq 0 \tag{17}$$

where it can be seen that introducing product market competition has a similar impact on the gains from trade as it did for the licensing case. Again letting δ approach 1, (17) becomes:

$$(1-\alpha)\Pi+\frac{\sigma_{ip}(1-\sigma_p)-\sigma_i-\sigma_p\phi(1-\sigma_{ip})}{\phi(1-\sigma_{ip})}\Pi\geq 0 \tag{18}$$

It is easy to see that as σ_p and σ_i approach σ_{ip} and σ_{ip} itself becomes large that this expression becomes negative. This mirrors the result in Proposition 3. Similarly, as both acquisition and licensing involve the removal of product market competition, its introduction as a potential outcome here does not change the choice between them as modes of cooperative commercialization.

From a welfare perspective, licensing now involves additional costs that must be traded-off against any benefits that might arise due to increasing the probability of entrant innovation. For acquisition, the already existing social costs are only exacerbated by the inclusion of a decrease in product market competition. Thus, the main predictions of the model without product market competition are preserved with its introduction here.

Multiple Innovators

The model previously assumes that there is only one innovation leader. This assumption drives the result that an incumbent innovator will choose the minimal research intensity. However, it is well-known that research competition can drive higher research intensities. In particular, for an incumbent, it may be motivated by a fear of preemption (Gilbert and Newbery, 1982). Here I demonstrate that even if two innovation leaders appeared to research towards a technology, while this would add to the incumbent's incentives to research more intensively, it is insufficient to cause it to do more than the minimal amount.

To see this suppose that, in a given period, there was an incumbent and an entrant innovation leader and that, otherwise, the model structure remained the same. In particular, to keep the exposition simple, suppose that, in the future, only one innovation leader will emerge per product generation. In addition, suppose that if, in a given period, both firms generate an innovation, the patent is randomly allocated to one firm (with equal probability).

In this case, (VI-i) becomes:

$$\begin{aligned} V_I^i &= (1-\phi_I)(1-\phi_E)(\Pi+\delta V_I^i)+\phi_I(1-\phi_E+\tfrac{1}{2}\phi_E)(\Pi+\sigma_{ip}\delta V_I^i+(1-\sigma_{ip})\delta V_I) \\ &\quad +(1-\phi_I)\phi_E(\Pi+\sigma_p\delta V_I^i+(1-\sigma_p)\delta V_I)+\phi_I\tfrac{1}{2}\phi_E(\Pi+\sigma_p\delta V_I^i+(1-\sigma_p)\delta V_I) \end{aligned} \tag{19}$$

The incentive to conduct research becomes:

$$\left(\tfrac{1}{2}\phi_E(2-\sigma_{ip}-\sigma_p)-(1-\sigma_{ip})\right)\delta(V_I^i-V_I) \tag{20}$$

Notice that this is increasing in ϕ_E. However, suppose that $\phi_E=1$, then it is easy to see that (20) is negative. Consequently, $\phi_I=0$ and so the entrant innovator will have the same research incentives as previously confirming the supposition that $\phi_E=1$. Thus, having in multiple innovators will not change the conclusions reached above.

6. Conclusion and Future Directions

This is the first paper to consider the option of negotiating for the market in a dynamic environment underpinned by competition for the market. It was demonstrated that dynamic considerations impact upon this decision in a way not captured by a purely static focus. In particular, the on-going roles of the parties of a licensing deal matter in terms of rent capture and the returns to licensing over competition. In turn, these on-going roles are related to dynamic capabilities – that is, the probability that a firm will have an innovative advantage in research towards the next generation of product based on its current role (as entrant or incumbent).

In this regard, perhaps 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 the question as to whether the firms could choose which one of them would return to innovative competition and which 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 anti-trust 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 on-going dissipation of monopoly rents. Similarly, the entrant could acquire the incumbent. However, this might necessarily preclude it from becoming a strong innovative entrant unless some form of restructuring was possible. Thus, there appears to be good 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.

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 exogenously. Either firms had them (to a certain degree) or they did not. In reality, the acquisition of such capabilities is likely to be a key and on-going strategic choice for firms. Thus, endogenizing this choice 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. Recent work by Adner and Zemsky (2005) goes 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 as considered here may lead to a richer picture of the innovation environment and the role of displacing or disruptive technologies on market and technological leadership in an industry.

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