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Entrepreneurial Commercialization Choices and the Interaction between IPR and Competition Policy*

Joshua S. Gans and Lars Persson

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Abstract

This paper examines the interaction between intellectual property protection and competition policy on the choice of entrepreneurs with respect to commercialization as well as the rate of innovation. We find that stronger intellectual property protection makes it more likely that entrepreneurs will commercialize by cooperating with incumbents rather than competing with them. Consequently, we demonstrate that competition policy has a clearer role in promoting a higher rate of innovation in that event. Hence, we identify one reason why the strength of the two policies may be complements from the perspective of increasing the rate of entrepreneurial innovation.

JEL codes: O31

Key words: Entrepreneurs, innovation, commercialization, intellectual property law, competition law.

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1. Introduction

Entrepreneurial innovations constitute a crucial ingredient in a well-functioning market economy. Scherer and Ross (1990), for instance, list a large number of break-through inventions made by independent innovators and state that "new entrants without a commitment to accept technologies have been responsible for a substantial share of the really revolutionary new industrial products and processes." In addition, Baumol (2004) documents that in the US, small entrepreneurial firms have created a large share of break-through inventions whereas large established firms have provided more routinized R&D. Further evidence of this is provided by Henkel *et al.* (2010) who undertake a qualitative empirical study of the electronic design automation (EDA) industry, and find that small independent firms are, indeed, the providers of breakthrough inventions.

We focus here on a particular aspect of entrepreneurship: their choice of commercialization strategy. While many entrepreneurs take their innovations directly to market, others often sell their innovation (business) to incumbents. We observe a significant amount of inter-firm technology transfers, ranging from joint ventures and licensing to outright acquisitions of innovations. These acquisitions might occur to prevent duplication of key complementary assets (Teece, 1987; Gans *et al.*, 2002; Braunerhjelm and Svensson (2010)), to reduce the effects of competition (Gans and Stern, 2000) or to integrate technologies. Granstrand and Sjölander (1990) present evidence from Sweden, and Hall (1990) presents evidence from the US that firms acquire innovative targets to gain access to their technologies. Bloningen and Taylor (2000) find evidence from US high-tech industries of firms making a strategic choice between the acquisition of outside innovators and in-house R&D, Lerner and Merges (1998) note that acquisitions are an integral part of know-how transfers in the biotech industry, and OECD argues that established firms often acquire firms to get access to new technologies.

As pointed out by Gans and Stern (2003, 2010) and Teece (1987), cooperative commercialization choices often rest on aspects of economic policy. They specifically point to intellectual property protection as being critical for allowing trade in ideas to occur.[1][2] Gans *et al.* (2002, 2008) confirmed the importance of this. However, there has been little discussion about the impact of competition policy on trade in ideas. Boone (2001) studies a model where an independent innovator sells an innovation to an oligopoly market incumbent through bargaining. He derives the existence of a non-monotonic relation between intensity of competition and the value of an innovation, indicating that there exists no easy prescription for competition authorities. Norbäck and Persson (2008) determine how antitrust policies affect the pattern of incentives for innovation for entry and innovation for sale. They show that a strict, but not too strict, merger policy tends to increase the incentives to innovate for sale by ensuring bidding competition for the innovation (leading to a greater *share* of rents accruing to the innovator), without reducing total rents for innovations too much.

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[1] The tax system has also been shown to be of importance for commercialization mode by affecting the possibilities of loss offsets in case of project failures (Haufler, Norbäck and Persson [2012], the development of venture capital markets [Lerner and Tåg [2013], and entrepreneurial firms' organizational form choices [Edmark and Gordon [2013]

[2] There is a literature examining the length (how long should an inventor be granted exclusivity) and the breadth (what should be considered infringements) of a patent; here the research seems to motivate having patents that are limited in time but that are not too narrow (see Regibeau and Rockett [2007], and Schotmer [2005] for an overview of this literature).

This paper examines the interaction between intellectual property protection and competition policy on the choice of entrepreneurs with respect to commercialization as well as the rate of innovation. To be sure, antitrust policy itself can be a barrier to cooperative agreements – especially ones motivated by the maintenance of incumbent market power. Because these matters are well covered, we focus here on the more nuanced aspects of competition policy – specifically, policies designed to protect entrants against preemptive use of incumbent market power (e.g., exclusionary customer contracts). Competition policy that favors entrants over incumbents can be subtle because, in some circumstances, entrants expect to become a future incumbent. Competition policy will impact on the rents from those expectations (Segal and Whinston, 2007; Gans, 2010).

The existing economic literature focusing on entrepreneurial innovation has shown that intellectual property law, most notably patents, facilitates technology transfer between firms in the market for ideas and thereby increases the commercialization of entrepreneurial inventions (Arora, 1995; Arora *et al.*, 2001; Gans *et al.* 2002). This literature also examines the determinants of patent licensing, the role of uncertainty in patent licensing, and the drivers of settlement in patent litigation (e.g., Katz and Shapiro, 1987; Gallini and Winter, 1985; Lanjouw and Lerner, 2001; Schankerman and Scotchmer, 2001).

The paper proceeds as follows. First we review both IP law and competition law as it compares between the US and the EU. Second, we provide a model of the dynamic impacts of competition law (building upon the work of Gans, 2011, and the informal discussion in Gans, 2010) on innovation/entrepreneurship, and compare the trade-offs in applying that law (notably its strength) as we move from an environment of competitive commercialization (associated with weak IP) to cooperative commercialization (associated with strong IP). We provide reasons why we expect these policies to be complements, that is, as you strengthen IP policy you also want to adopt a stronger competition policy and vice versa. We do this from the perspective of targeting a higher rate of innovation rather than impacts on consumer welfare where the two policies are known to have substitutable effects. A final section concludes.

2. Legal Strength and Trends

Here we review broad trends in the EU and US in terms of the strength of intellectual property and competition law.

INTELLECTUAL PROPERTY LAW

The purpose of intellectual property law is to reward the innovation and creation of new technologies/ideas, and facilitate the spread of these through the granting of exclusive rights to utilize a new invention, new information or a cultural good. IP law is, typically, divided into patent, copyright law and trademarks, but we will here focus on patent law. The patent law offers inventors the right to exclude others from making, using, selling, offering for sale, or importing their invention for a number of years (often around 20 years). This law is uniquely powerful in IP law, enforceable even against inventors who independently create the same device.

Intellectual property protection has increased in both the US and the EU (including Sweden) in recent decades. According to EU law, a patent can be awarded given that an invention satisfies certain criteria. First, the invention must be new, i.e., you cannot patent something that is "publicly known" (e.g., through previous publications, presentations, or the use thereof), even though no one ever thought of patenting it. Second, the creation must have "height" (meaning that it must be sufficiently different from previously known techniques) and "industrial applicability" (in the sense that it could be used commercially), and that it must be a technical solution to a problem *and* solve this problem (Article 52 of the EPC).

The United States has a longer tradition in IP law. US patent law was established "to promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries" as provided under Article 1, section 8(8), in the US Constitution. However, over time and especially with respect to Patent Law Reform in the US in 2011, the EU and US policies have become increasingly similar.

In both jurisdictions significant strengthening has occurred. In the US, a new Federal Court of Appeals specializing in patents and other IPR matters was established in the 1980s and during its period of tenure the number of patents granted in the USA has increased at a rapid rate.[3] In the 1980s 61,819 Utility Patents were granted and as compared to 219,614 in 2010.[4] The number of so-called EPO patents granted in the EU increased from 34,702 in 2001 to 58,108 in 2010. In Sweden, the number of patents granted has decreased from 2126 in 2000 to 1379 in 2010. The decrease in Sweden is likely due to the increase in EPO patents granted to Swedish inventors.

COMPETITION LAW

The main motivation for the competition law is that it should prevent business strategies aiming at reducing competition in the market too much. Typically, the competition law is divided into three legs: (i) anti-monopolization law, which prohibits business strategies of dominating firms aiming at monopolizing markets. (ii) anti-collusion law, which aims at preventing collusion that increases prices in the market, and (iii) merger control law, which aims at blocking mergers that lead to welfare reducing increases in the market power of firms.

EU competition law has become increasingly strict, making it approach (if not even exceeding) the strength of its US counterpart, both in its scope of firm behavior controlled and its practice. The basic premise behind the EU competition law is that competition is a basic mechanism of the market economy and encourages companies to provide consumers the products they want at low prices.

The EU competition law covers two prohibition rules set out in the Treaty on the Functioning of the European Union. First, agreements between two or more firms which restrict competition are prohibited (Article 101 of the Treaty), subject to some minor exceptions. This provision covers a wide variety of actions. The most obvious example of illegal conduct infringing Article 101 is a cartel between competitors (which

[3] See Anderman (2007). On September 16, 2011, President Barack Obama signed into law the *Leahy-Smith America Invents Act*. This Act brought the most comprehensive overhaul to the US patent system since 1836.

[4] Source: *U.S. Patent Statistics, Calendar Years 1963–2010*, United States Patent and Trademark Office.

may involve price-fixing or market sharing). Second, firms in a dominant position may not abuse that position (Article 102 of the Treaty). This is for example the case for predatory pricing aiming at eliminating competitors from the market.

In the US, Congress passed the first antitrust law, the Sherman Act, in 1890 as a "comprehensive charter of economic liberty aimed at preserving free and unfettered competition as the rule of trade." In 1914, Congress passed two additional antitrust laws: the Federal Trade Commission Act, which created the FTC (Federal Trade Commission), and the Clayton Act. With some revisions, these remain the core federal antitrust laws in effect today.

The antitrust laws proscribe unlawful mergers and business practices in general terms, and leaves to courts to decide which ones are illegal on a case by case basis. The very first sentence of the Sherman Act criminalizes the act of anti-competitive behavior, stating that "[e]very contract, combination in the form of trust or otherwise, or conspiracy, in restraint of trade or commerce […] is declared to be illegal" (Title 15(1), §1), and in its second paragraph it outlaws even the attempt to monopolize a market: "[e]very person who shall monopolize, or attempt to monopolize, or combine or conspire with any other person or persons, to monopolize any part of the trade or commerce […] shall be deemed guilty of a felony".

Long ago, the Supreme Court decided that the Sherman Act does *not* prohibit **every** restraint of trade, only those that are **unreasonable**. However, certain acts are considered so harmful to competition that they are almost always illegal. These include plain arrangements among competing individuals or businesses to fix prices, divide markets, or rig bids. These acts are **per se** violations of the Sherman Act; no defense or justification is allowed. The subsequent Federal Trade Commission Act from 1914 established the FTC, giving it the authority to "[…] prevent persons, partnerships, or corporations […] from using unfair methods of competition in or affecting commerce and unfair or deceptive acts or practices in or affecting commerce" (Title 15(2), §45)).

The Clayton Act addresses specific practices that the Sherman Act does not clearly prohibit, such as mergers if the effect "may be substantially to lessen competition, or to tend to create a monopoly" (Title 15(1), §18). Over the last decades it seems clear that the strength of and scope of IPR has increased both in the US and EU. In the US, the total corporate fines imposed by the Department of Justice have increased from $271 million in 2001 to $339 million in 2010.[5] In the EU cartel fines imposed by the European Commission (adjusted for Court judgments) has increased from €3.2 billion in the period 2000–2004 to €8.9 billion in the period 2005–2009.[6]

THE INTERACTION BETWEEN COMPETITION LAW AND IP LAW

According to Carrier (2009), the US courts refused to impose antitrust liability for patent based activity in the period 1890 to 1912. However, Congress responded to the courts' ignorance of the antitrust concerns in patent cases, by enacting the Clayton Act, which prohibited the tying of patented and unpatented products.

5 Source: The United States Department of Justice, Antitrust Division http://www.justice.gov/atr/public/criminal/264101a.html (accessed 2011-09-27).

6 Source: European Commission http://ec.europa.eu/competition/cartels/statistics/statistics.pdf (accessed 2011-09-27).

The Courts thereafter began to recognize antitrust restrictions on patentees (see e.g., Carbice Corp. of America v. American Patents Development Corp). Beginning in the 1970s, the courts retreated from the overtly hostile approach to various IP arrangements. They began to follow a more economic-based approach, analyzing the competitive effects of arrangements (see, e.g., Continenta T.V., Inc. v. GTE Sylvania, Inc.). This process has continued, and IP has gained a strong position over antitrust in the US courts; a predominance maintained in the first decade of the 21st century.

EU law was originally quite hostile to IPRs, focusing instead on encouraging competition. There has later been a shift towards the view that an IPR does not necessarily result in a monopoly that is harmful to competition. Even with that shift, however, the EU still tends to protect IP less than countries such as Japan or Australia (Anderman and Schmidt 2007, p. 37–38). In *Parke Davis* it was laid down that "higher sale price for a patented product…does not necessarily constitute an abuse" (Anderman and Schmidt 2007, p. 51). Still, EU law may not allow IP owners to charge the full value of the IPR as it is conceived by national law. That is, dominant firms may only charge a price that would give them a fair return. Refusal to grant license in primary markets, even under a dominant position or monopoly, is not prohibited by Article 82, but to acquire a competing innovative technology can be. Refusal to license in a secondary market may however violate the same article (82b). Buying out competition is not considered to be competition on the merits (Anderman and Schmidt 2007, pp. 52–57). When it comes to dealing with collusion under Article 81(3), the Commission has moved from a legalistic approach to a more economic approach (Anderman and Schmidt 2007, p. 84).

In conclusion, we can see that, relative to the EU, the US places a greater weight on the strength of IP law relative Competition Law. That is, it protects incumbent innovators more than it protects entrepreneurial entrants. We will now examine the implications of this difference in a dynamic model of start-up commercialization choices. Our starting point is that a stricter IP law improves the opportunities of sale and licensing of inventions, and a more stringent competition law strengthens the position of entering innovators.

3. A Dynamic Model of Start-Up Commercialization Choices

The basic set-up of this model follows Segal and Whinston (2007; hereafter SW), but with an important generalization. Whereas SW assume that a displaced incumbent becomes an innovating entrant with certainty, we allow for more competition amongst entrants engaged in innovative activity. In this model, it is no longer the case that a displaced incumbent becomes the innovating entrant with certainty. This becomes important when considering cooperative commercialization, as incumbents cannot be guaranteed the role of innovating entrant in the future.

FIRMS AND INNOVATIONS

We use an infinite horizon, discrete time model, with a common discount rate of $\delta \in [0,1]$ for all participants. Innovations occur sequentially with each innovation being a new product that yields valuable quality advantages over the previous generation. The firm that develops the innovation receives an infinitely lived patent; although the expected economic life of the product will be finite. At any given point in time there is one firm, the incumbent (*I*), which holds the patent rights to the current leading product or generation of products. Apart from the first period, the product generates a constant flow of monopoly rents, π_m, until it is displaced by a new innovation.

We follow SW's assumption that the current incumbent does not engage in R&D. Rather, it is an entrant's R&D that leads to an innovation.[7] This entrant is drawn from a pool of firms which is infinite in number and may include the previously displaced incumbent or, if there is no such displacement as a cooperative deal is negotiated, the previous innovating entrant. The probability that a displaced incumbent becomes the next lead entrant innovator is σ_I, while that probability is σ_E for the prior entrant innovator if they have not become the incumbent. These probabilities may reflect dynamic capabilities that each firm has accumulated through its past activities as a producer (for the incumbent) or as an innovator (for the entrant).[8]

In each period, the entrant innovator, *E*, chooses its R&D intensity, $\phi \in [0,1]$ this is also the probability that it generates an innovation in the current period. Let the cost of R&D be denoted by $c(\phi)$, where *c*(.) is an increasing, strictly convex function with $c(0)=0$. In this set-up, an entrant has an incentive to engage in positive R&D effort as this can only lead to improved profits.

COMMERCIALIZATION CHOICES

When a new product is generated by an entrant in period *t*, the patent holder, *E*, faces a choice in that period. It can enter into production of the product generation (we call this commercialization strategy "competition") or it can negotiate with the current incumbent (we call this commercialization strategy "cooperation").[9] Following the entrant's decision, Nature decides which of the remaining firms that do not hold patent production rights to the current product generation and, thus, becomes the next entrant for research towards the next product generation.

If *E* chooses to compete, *I* can no longer achieve monopoly profits in period *t*. Instead, *I* earns π_I and *E* earns π_E (where $\pi_I + \pi_E \leq \pi_m$). If the entrant competes, it incurs a fixed cost of *f*, which is sunk. We assume that such entry is credible; that is, $\pi_E \geq f$. The fact that the entrant incurs a fixed cost, but the incumbent does not, implies that incumbency is valuable. This plays a role in the nature of competitive dynamics. In period *t+1*, if the next entrant has not invented a product, *E* assumes the role of *I* and earns a profit flow of π_m until another entrant generates a new product. The previous incumbent then joins the pool of firms from which the next entrant will be selected. For simplicity, it is assumed that incumbent would have to sink costs, *f*, if it wished to re-enter the product market with a new future innovation.

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[7] Gans (2011), considers a model whereby the current incumbent can also engage in R&D. There it is noted that such incumbents have an incentive to engage in a minimal level of R&D so as to slow down the arrival of the next innovation and avoid cannibalization of existing products. Thus, the assumption here can be considered as a natural one when incumbents have literally no incentive to expend resources on innovation..

[8] The role of dynamic capabilities is addressed in more detail in Gans (2011). Here it is included so as to explore the robustness of the conclusions in SW and below to the possibility that current firms have imperfect chances of becoming future innovators in the industry. See also Sutton (2002).

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

Alternatively, if *E* engages in cooperative commercialization it negotiates to sell *I* an exclusive license to its innovation. [10] Alternatively, *E* could be acquired by *I*; however, as we explain below, this turns out to be a special case of licensing. We assume that such negotiations take the Nash bargaining form where the entrant and the incumbent have equal bargaining power, parameterized by γ.[11] If a licensing deal is successfully negotiated, *E* receives a once-off payment, τ, while *I* preserve its monopoly position. A licensing agreement allows the firms to avoid a competitive period in which only sub-monopoly profits can be earned, and allows *E* to avoid incurring any entry cost, *f*. If *E* chooses to cooperate, *E* is the one who returns to the pool of firms as a potential future entrant, while *I* remain the incumbent.

IMPACT OF ANTITRUST

SW assume that profits under competition for both *I* and *E* and under monopoly may depend on policies of antitrust enforcement. They represent the strength of such policies by a parameter, α, where higher values of α represent policies that are more protective of entrants. In other words, they assume that $\pi'_E(\alpha) > 0$. In general, a policy that protects an entrant in competition will not favor the incumbent. For this reason, here we will also assume that $\pi'_I(\alpha) \leq 0$. Antitrust policies may also have an impact on monopoly profits, but it is not clear how, as the impact is likely to depend upon the specific nature of the policy. For instance, when incumbents engage in costly actions in an attempt to prevent future entry (e.g., exclusive contracting), stand-alone monopoly profits might actually be higher if there is a protective antitrust policy in place. In other situations such a policy might put a regulatory burden on incumbents and so a more restrictive policy could cause π_m to fall. As in SW, our primary interest is in the impact of a more restrictive policy on the rate of innovative activity amongst entrants.

COMPETITIVE COMMERCIALIZATION

To provide a point of comparison with SW, we begin with the case where licensing is not possible. In the infinite-horizon dynamic game, following SW, we confine attention to stationary Markov perfect equilibria using SW's dynamic programming approach. For this purpose, let V_I and V_E be the expected present value of profits, at the beginning of any given period of an incumbent firm and an innovating entrant, respectively.[12] These values will satisfy:

$$V_E = (1-\phi)\delta V_E + \phi(\pi_E - f + \delta V_I) - c(\phi) \qquad \text{(VE)}$$

$$V_I = (1-\phi)(\pi_m + \delta V_I) + \phi(\pi_I + \sigma_I \delta V_E) \qquad \text{(VI)}$$

[10] It is implicitly assumed that if *E* were to engage in non-exclusive licensing, the resulting on-going competition between the two firms in the product market would be so intense that entry would not be credible. Of course, licensing terms can be used as a tool to soften such competition. There is no need to consider this case separately, however, since exclusive licenses, which include terms that soften competition, and non-exclusive licenses would have the same impact on profit.

[11] 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.

[12] The remaining entrants in the pool earn an expected continuation value of zero and so need not be considered in deriving the equilibrium outcomes.

Note that, following an entrant innovation, the entrant continues in the industry by default (as the incumbent) while the incumbent only continues in the industry as an innovating entrant with probability, σ_I.

For an entrant innovator, the equilibrium level of R&D intensity is given by the following equation:

$$\phi \in \arg\max_{\varphi \in [0,1]} \left\{ \varphi\left(\pi_E - f + \delta(V_I - V_E)\right) - c(\varphi) \right\}$$

Following SW, we let *W* denote the "innovation prize or benefit." In this case,

$$W = \pi_E - f + \delta\left(V_I - V_E\right) \qquad \text{(IB-Comp)}$$

so that an entrant is effectively solving in each period:

$$\phi \in \arg\max_{\varphi \in [0,1]} \left\{ \varphi W - c(\varphi) \right\} \text{ (IS)}$$

Since *c*(.) is convex, this gives an "innovation supply" relationship between the quantity of R&D (ϕ) and its price (*W*). In each different case considered in this paper, the (IS) relationship will remain the same, but the value of *W* will change. Note that the convexity of R&D costs implies that ϕ is non-decreasing in *W*.

The equilibrium level of R&D by the entrant is determined by solving (VI) and (VE) simultaneously and using these equations to find the intersection of the (IB) and (IS) functions. The (IB) equation describes the "innovation benefit" relationship between R&D intensity (through $V_I - V_E$) and the level of the innovation prize. Solving (VI) and (VE) simultaneously yields:

$$V_E = \frac{(1+\delta(-1+\phi))c[\phi] + \phi(-\delta\phi\pi_I + (-1+\delta-\delta\phi)(\pi_E - f) + \delta(-1+\phi)\pi_m)}{-(1+\delta(-1+\phi))^2 + \delta^2\phi^2\sigma_I}$$

$$V_I = \frac{-(1+\delta(-1+\phi))(\phi\pi_I - (-1+\phi)\pi_m) + \delta\phi(c[\phi] + \phi(f - \pi_E))\sigma_I}{-(1+\delta(-1+\phi))^2 + \delta^2\phi^2\sigma_I}$$

Any level of R&D intensity that jointly satisfies (IS) and (IB) is a stationary equilibrium of the R&D game. Figure 1 depicts a possible equilibrium outcome. The equilibrium rate of innovation, $\hat{\phi}$, occurs where the (IS) and (IB) curves intersect.[13] At this stage, it is useful to note that the equilibrium level of R&D will be non-decreasing in δ, non-decreasing in π_m, non-decreasing in σ_I and non-increasing in *f*.[14] An increase in the first three parameters causes the IB curve to shift outwards while an increase in *f* causes it to shift inwards. The IS curve is invariant to changes in these parameters.

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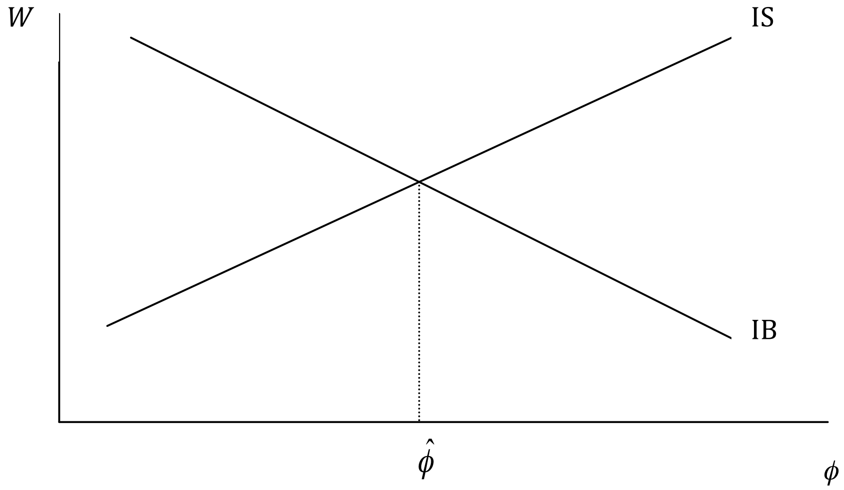
[13] The IB curve may not be monotonic. SW demonstrate, however, that the same qualitative analysis holds for non-monotonic functions. For this reason, we simplify the graphical exposition by depicting more familiar downward sloping case; for convenience, we have also drawn these curves as straight lines.

[14] This can be seen by taking the derivative of *W* in (IB-Comp) with respect to each variable and applying Theorem 1 of Milgrom and Roberts (1994) on the corresponding set of equilibria.

Figure 1. Equilibrium under Competition



It is interesting to consider the intuition behind the comparative static results for σ_I. The more likely it is that the incumbent will persist in the industry (by becoming the next lead entrant in the event that it is replaced by an entrant with a new innovation), the higher is V_I. As long as $V_E > 0$, the higher the incumbent's chances of reentering the market tomorrow is, the higher is the net present value of being the incumbent today. The value associated with being the lead entrant depends not only on the next period's profit in which the entrant shares the market with the incumbent, but also the profit associated with playing the role of incumbent in any future period. Thus V_E is also increasing in σ_I. In the event that the entrant produces a successful innovation, the incumbent will reenter the market as a lead entrant with probability σ_I, whereas the entrant will reenter with probability $\phi\sigma_I$ – the entrant must first be overthrown by the current lead entrant. Thus, since the incumbent's benefit from a higher value of σ_I is more immediate and more likely, an increase in σ_I unambiguously raises the incumbency advantage ($V_I - V_E$) and hence the innovation benefit.

This means that under competition, the more likely an incumbent is to innovate in the event that it is displaced, the higher the rate of innovation in the industry. On the whole, we would expect the incumbent to prefer a lower rate of innovation. If an increase in innovation intensity is a result of a rise in σ_I, however, the incumbent benefits from this rise in innovation intensity. The cost to the incumbent associated with an increased probability of being displaced today is outweighed by the benefit associated with an increased probability of being the new entrant tomorrow. Indeed, if the incumbent were required to pay to reenter the pool of potential new entrants it would be willing to pay up to $\phi\delta V_E$ for the option of future reentry into the market with probability, σ_I. Since the entrant would be willing to make a similar payment (as it expects to become the incumbent one day), the entrant's willingness to invest in innovation is even greater. Both of these effects add to the incumbent's willingness to pay for σ_I.

We can now analyze the impact of antitrust policy (α) on the optimal choice of investment in R&D. As noted above, such policies do not shift the (IS) curve but will have an effect on the (IB) curve through their impact on the 'innovation prize,' *W*. Thus, the following proposition can be proved:

Proposition 1. *Under competitive commercialization, a stronger antitrust policy will increase the equilibrium rate of innovation if:*

$$\pi_E'(\alpha) + \tfrac{\delta}{1-\delta(1-\phi)}\big((1-\phi)\pi_m'(\alpha) + \phi\pi_I'(\alpha)\big) \geq 0 .$$

The proof of the proposition involves substituting the expressions for V_I and V_E above into (IB-Comp) and taking the derivative with respect to α. The conditions under which a stronger antitrust policy leads to more innovation when incumbents become entrants with probability less than one, are identical to the conditions derived by SW under which a stronger antitrust policy leads to more innovation when displaced incumbents become the next entrant with certainty. Hence the impact of antitrust policies on the intensity of innovation is independent of σ_I. Thus, SW's result also holds when displaced incumbents do not become entrants with certainty.

Intuitively, a more restrictive antitrust policy will have two effects on entrant innovation. First, more restrictive antitrust policy directly increases the entrant's immediate post-entry profits. Second, a rise in α will indirectly reduce the value of being the lead entrant since it reduces the value the entrant receives from becoming the new incumbent (since the incumbent's immediate post entry profits are decreasing in α, and the incumbent is subject to the same policy as the entrant). If the first effect outweighs the second, stronger antitrust policy will boost innovation. Specifically, antitrust policy is most effective at stimulating greater entrant innovation when the returns to such innovation are *front-loaded* in time.

LICENSING AND COOPERATIVE COMMERCIALIZATION

We now turn to consider licensing.[15] We will continue to assume that entry is credible, and so $\pi_m \geq f$. If the incumbent negotiates with a patent holder, the incumbent earns $\pi_m - \tau + \delta V_I$, where τ is the license fee; otherwise, the incumbent expects to earn $\pi_I + \sigma_I \delta V_E$ (as entry occurs and incumbency is lost). The innovator expects to earn $\tau + \sigma_E \delta V_E$ from licensing (as it may not persist in the industry) and $\pi_E - f + \delta V_I$ otherwise (as it becomes the incumbent with certainty).

There will be gains to trade from licensing if:

[15] As noted in the introduction, licensing is only one form of cooperative commercialization. It fits the formal model and so we focus upon it here; comments on how other forms of cooperation change the results, however, can be found in the concluding section.

$$\underbrace{\pi_m - \tau + \delta V_I + \tau + \sigma_E \delta V_E}_{\text{Joint Payoff from Cooperation}} \geq \underbrace{\pi_I + \sigma_I \delta V_E + \pi_E - f + \delta V_I}_{\text{Joint Payoff from Competition}} \quad (1)$$
$$\Rightarrow \pi_m - (\pi_I + \pi_E - f) \geq \left(\sigma_I - \sigma_E\right)\delta V_E$$

Note that cooperation avoids the dissipation of monopoly rents and the sunk costs of entry, $\pi_m - (\pi_I + \pi_E) + f$. These are the same factors that drive the gains from trade for licensing in static models (see Salant, 1984; Gans and Stern, 2000).

In this dynamic model, however, there are additional forces that raise the joint surplus from licensing. First, a license agreement will allow the incumbent to preserve its net present value and will preclude any other entrants from capturing this. As there is only one incumbency rent, this nets out as a gain from trade from licensing.

When the incumbent and entrant cooperate, the probability that either party becomes the subsequent incumbent is σ_E, the probability that the entrant remains the lead entrant in the next round. When they compete, however, this probability is σ_I . Then, if $\sigma_E > \sigma_I$ licensing increases joint surplus by $(\sigma_E - \sigma_I)\delta V_E$. If $\sigma_E < \sigma_I$, however, licensing can result in a fall in joint surplus of $(\sigma_I - \sigma_E)\delta V_E$. This might occur if the entrant has a more specialized focus on the current generation whereas the incumbent has capabilities that give it an R&D advantage in the next generation.

Take the extreme case where $\sigma_E = 0$ and $\sigma_I = 1$. By signing a licensing agreement, both parties lose the option to be the lead entrant in the future. If the agreement is not signed, however, the incumbent becomes the entrant in the following round, and so earns $\pi_I + \delta V_E$. In effect, the licensing agreement confers a *positive externality on a third party* (a potential entrant), which is internalized if no licensing agreement is reached. On the one hand, if the two parties compete the next entrant will necessarily be the incumbent. On the other hand, if they negotiate a license, the next entrant will be a third party. So, whenever $\delta V_E > \pi_m - (\pi_I + \pi_E - f)$, the overall gains from trade from licensing will not be positive and licensing will not occur.

As the continuation payoffs are endogenous, care must be taken to establish the existence of equilibrium with licensing. Determining the conditions under which licensing will actually take place in equilibrium involves deriving the equilibrium value of continuation values under licensing; but this requires a solution for τ. Given this, we 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:

$$\max_\tau \left(\pi_m - \tau + \delta V_I - \pi_I - \sigma_I \delta V_E\right)^{1-\gamma} \left(\tau + \sigma_E \delta V_E - (\pi_E - f + \delta V_I)\right)^\gamma \quad (2)$$

This gives $\tau = \gamma(\pi_m - \pi_I) + (1-\gamma)(\pi_E - f) + \delta\left(V_I - (\gamma\sigma_E + (1-\gamma)\sigma_I)V_E\right)$.

In the licensing case, the (conjectured) equilibrium continuation payoffs are:

$$V_I = \pi_m + \delta V_I - \phi\tau \qquad \text{(VI)'}$$

$$V_E = (1-\phi)\delta V_E + \phi(\tau + \sigma_E \delta V_E) - c(\phi) \qquad \text{(VE)'}$$

Notice that, along the (conjectured) equilibrium path, incumbency involves a continual flow of monopoly profits (π_m) 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 over the economic life of the patent.

In this case, the innovation prize is:

$$W = \tau - (1-\sigma_E)\delta V_E \qquad (3)$$

Thus, as in the case of competition, under cooperation the (IB) curve includes a factor based on the value of incumbency; through τ, even though this is never lost in (the conjectured) equilibrium. Nevertheless, entrant innovators can still appropriate part of this in negotiations over the license fee.[16] The (IS) relationship remains the same as the no licensing case. The resulting equilibrium continuation values are given in the appendix.

We are now in a position to (partially) characterize the equilibrium outcome.

Proposition 2. *Licensing is an equilibrium outcome for δ sufficiently small and/or $\sigma_E \geq \sigma_I$. Licensing is not an equilibrium outcome as $\delta, \sigma_I - \sigma_E \to 1$.*

The proof is given in the Appendix. The intuition behind this proposition can be understood by examining (equation 1). The conditions under which licensing may not be an equilibrium outcome are addressed in more detail in Gans (2011). As the purpose of this paper is to analyze the impact of antitrust policy when licensing is an equilibrium outcome, in the remainder of the paper it will be assumed that $\sigma_E \geq \sigma_I$.

It is worth noting that the rate of innovation when licensing is an equilibrium outcome is higher than it would be if licensing were prohibited. The entrant only agrees to a licensing arrangement if its payoff under cooperation exceeds that under competition [17]

THE IMPACT OF ANTITRUST POLICY

Having set-up a licensing equilibrium as a variant of the competitive equilibrium established in the original SW model, the impact of stronger antitrust policy can be examined in further detail. The following

[16] Of course, this would not be possible if product market entry were not credible. Note, however, that this does not require the innovator to exercise this entry option, merely to threaten it (see also Anton and Yao, 1994).

[17] That is, $W^{COOP} \geq W^{COMP} \Rightarrow \tau - (\pi_E - f) \geq \delta\left(V_I^{COMP} - V_E^{COMP} + (1-\sigma_E)V_E^{COOP}\right)$ which always holds with strict inequality except as $\delta \to 1$, in which case it holds with equality.

proposition shows that like in the competitive equilibrium, under certain conditions, stronger antitrust policy will lead to greater innovation:

Proposition 3. *Under cooperative commercialization, a stronger antitrust policy will increase the equilibrium rate of innovation if:*

$$(1-\gamma)\pi_E'(\alpha)-\gamma\pi_I'(\alpha)+\tfrac{\gamma+\delta(1-\gamma)}{1-\delta}\pi_m'(\alpha)\geq 0\,.$$

The proof of this proposition is analogous to the proof of Proposition 1. Unlike the competitive commercialization case, however, when $\pi_m'(\alpha)=0$ and licensing is expected, stronger antitrust policy will *always* increase the equilibrium rate of innovation, since antitrust policy both improves the entrant's profits and reduces the incumbent's profits under competition. In contrast, the prize (which is determined primarily through the license fee paid to the entrant) depends on the weighted difference between π_E and π_I, rather than their sum. Since *E* never becomes the incumbent in a cooperative equilibrium, any increase in the license fee caused by a stronger antitrust policy is never a detriment to its research incentives. Hence, *E* strictly prefers stronger antitrust protection.

That said, when $\pi_m'(\alpha)<0$, stronger antitrust policy can dissipate the rents available to the incumbent, the gains from licensing, and hence the license fee that the entrant can extract from the incumbent. The higher the level of entrant bargaining power (γ), the greater the entrant's share of those rents and the greater the impact that a strict antitrust policy has on the innovation rate. When $\gamma=1$, the condition under which stronger antitrust policy leads to more innovation becomes $\pi_E'(\alpha)-\pi_I'(\alpha)+\tfrac{1}{1-\delta}\pi_m'(\alpha)\geq 0$. Thus, it is possible that stronger antitrust policy could reduce entrant innovation. If the discount factor is low or the impact on standalone monopoly profits are large, the negative role that the policy plays on monopoly profits outweighs the gains associated with entrant innovation so that antitrust policy hinders innovation.

ACQUISITION

Licensing is not the only form of cooperative commercialization. Another commonly practiced strategy involves the start-up being acquired by the incumbent firm. This may occur in situations where a licensing agreement or shift in intellectual property rights is infeasible. The difference between acquisition and licensing is that the start-up (or entrant, in this model) is removed from the pool of potential innovators for the next generation. In effect, $\sigma_E=0$.

It is readily apparent that, compared with licensing, there are lower gains from trade from acquisition as the externality handed to third party potential entrants is higher. Nonetheless, it is clear from Proposition 3 that the qualitative impact of antitrust policy is the same as in the licensing case, since the conditions under which tighter policies lead to more intense innovation do not depend on σ_E.[18]

4. Long-Term (Exclusive) Contracts

We now consider a key example addressed in SW to determine how (i) relaxing the assumption that displaced incumbents become the innovating firm in the following period, and (ii) how allowing entrants and incumbents the opportunity to cooperate, changes our predictions about certain findings.

SW consider a model in which the incumbent can sign long-term exclusive contracts with all or some of its current customer base. They use a quality ladder model in which the customer base lies on the unit interval and *each* product innovation raises each consumer's utility by a fixed quantity, Δ. In the absence of exclusive contracts, the focal Bertrand competitive equilibrium is that $\pi_m = \pi_E = \Delta$ and $\pi_I = 0$. They compare this to the case in which the incumbent offers an exclusive contract to a share of its consumers, *B*, in the form of a fixed price for delivery of their product in the next period. Contracts can only be written at most one period in advance.

If a consumer is offered an exclusive contract at a price of q_{t+1}, the only risk they face in accepting the contract is the possibility that the entrant innovates in the current period. In the event that the current entrant innovates, the consumer forgoing a potential gain in utility, and thus, their expected opportunity cost is $\phi\Delta$. Thus, the consumer only accepts a long-term exclusive contract if $q_{t+1} \leq (1-\phi)\Delta$; that is, the benefit associated with the improved technology, discounted by an amount that reflects the fact that with probability ϕ the consumer could have purchased a product of equal quality from the new entrant. Offering this contract costs the incumbent $(1-\phi)^2\Delta$, multiplied by the probability that the entrant does not innovate. Nonetheless, SW demonstrate that the incumbent will sign exclusive contracts with as many consumers as possible, within the bounds of antitrust law (antitrust restrictions are modeled using the parameter $1-\alpha$, defined as the permissible share of consumers who can receive long-term exclusive contracts; due to its negative impact on entrant R&D rates). When the incumbent can offer exclusive contracts to existing customers profits are given by $\pi_m = \alpha\Delta + (1-\alpha)(1-\phi)\Delta$, $\pi_E = \alpha\Delta$ and $\pi_I = (1-\alpha)(1-\phi)\Delta$. Plugging these into the condition in Proposition 1, it is clear that stronger antitrust policy leads to more innovation in this model.

When cooperative deals can be struck, the analysis of long-term exclusive contracts becomes (surprisingly) more straightforward, and the impact of antitrust policy becomes unambiguous. When the entrant is expected to license to the incumbent, the incumbent's product quality increases by Δ. Suppose that this event means that the two generations of old technology become publicly available. Thus, the incumbent

[18] Of course, the acquisition and licensing decisions themselves might, in richer environments, have impacts on the rate of innovation and on-going consumer welfare. Those issues are explored in Gans (2010).

monopolist can charge non-contracted consumers 2Δ.[19] The question is: what price can the incumbent charge consumers for a contract covering the product in the next period? Assume that this product will always be the latest generation in the incumbent's hands (either its current or the next generation should the entrant innovate and license to the incumbent). While under competitive commercialization, the incumbent had to offer those contracts at a discount due to the potential competition coming from the entrant, when consumers expect the entrant to license to the incumbent, no such competition will be forthcoming. Hence, the incumbent could offer a modest, arbitrarily small discount to consumers for exclusive contracts that they would all accept. As the cost of doing so is minimal, the incumbent will offer such contracts up to the antitrust constraint, $1-\alpha$.

In this situation, profits are given by $\pi_E = \alpha\Delta$, $\pi_I = (1-\alpha)\Delta$, and $\pi_m = \Delta$. Thus, the antitrust constraint does not impact on standalone monopoly profits. Plugging these into the condition in Proposition 3, it becomes clear that the stricter the antitrust policy, the more intense innovation will be. Intuitively, a ban on exclusive contracts improves the entrant's prospects under competition – there is a redistribution of rents from the incumbent to the entrant of an amount 2Δ per additional non-contracted or 'free' consumer. This is built into the license fee and thereby increases the innovation price. There is, therefore, arguably a stronger motivation for a ban on exclusive contracts that lock in consumer to the incumbent when cooperative commercialization is expected than in the competitive case.

5. Conclusion

This is the first paper to consider the choice of start-up commercialization strategy in a dynamic environment. It was demonstrated that the impact of dynamic considerations upon this decision is 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 R&D towards the product generation based on its current role (as entrant or incumbent). These capabilities feed-back to determine the general relationship between commercialization activities of start-ups and their share of innovation across industries.

We show that stronger intellectual property protection makes it more likely that entrepreneurs will commercialize by cooperating rather than competing. Competition policy has then a more important role in promoting a higher rate of innovation by protecting entrants from incumbents' bargaining power in their cooperative arrangement. Hence, we identify one reason why the strength of the two policies may be complements from the perspective of increasing the rate of entrepreneurial innovation.

Given that in the balance between IP law and competition law, the US put more emphasis on IP law than the EU, and that US competition law is built more on rule of reason than *per se* rules (as is the case with EU merger law), this may indicate that US law encourages cooperative commercialization more than EU law.

[19] Strictly speaking the argument will hold so long as there are a fixed number of product generations held by the incumbent at any period of time.

Our finding that the strength of intellectual property protection law and competition law may be complements from the perspective of increasing the rate of entrepreneurial innovation, thus indicates that the strong position of competition law in the US and the strengthening of the US intellectual property protection law over the last decades may explain the strong productivity growth in the US of the last decades. The recent joint strengthening of competition law and intellectual property protection law in the EU might indicate that such a productivity increase may also occur in the EU over the coming decades if this development continues.

However, our analysis also shows that the devil is in the details and more general conclusions are difficult to obtain due to the intricate interaction between IP law and competition law, and their effect on the incentive to innovate. Thus, more in-depth research seems highly warranted on this topic.

Appendix

PROOF OF PROPOSITION 2

Using the values computed above, substituting them into (1), and taking the limit as δ approaches 0, we get $\pi_m - (\pi_I + \pi_E - f) > 0$. Also, looking at (1), if $\sigma_E = \sigma_I$, the same value arises. So licensing is an equilibrium in either case.

For the possibility that licensing is not an equilibrium, note that for $\sigma_I = 1$ and $\sigma_E = 0$, taking the limit as δ approaches 1, the gains from trade become:

$$\pi_m - (\pi_I + \pi_E - f) - \frac{\pi_m - c(\hat{\phi})}{\hat{\phi}} \qquad (4)$$

We wish to show that this is negative. Suppose that it is not. Re-arranging we have: $-(\pi_I + \pi_E - f)\hat{\phi} \geq \pi_m(1-\hat{\phi}) - c(\hat{\phi})$. Note that, as $\delta \to 1$, $W \to c(\phi)/\phi$. At $\hat{\phi}_E$, this implies that $c(\hat{\phi}) \to c'(\hat{\phi})/\hat{\phi}$, which, as *c*(.) is non-decreasing with *c*(0) = 0, can only be true if $\hat{\phi} \to 0$ (as this is the point where average cost equals marginal cost). Thus, in equilibrium, (4) cannot be positive and so licensing is not an equilibrium outcome in this case.

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