PUBLIC SECTOR SCIENCE AND THE STRATEGY OF THE COMMONS

AJAY AGRAWAL
Queen's School of Business, Queen's University
Kingston, Ontario, Canada, K7L 3N6

LORENZO GARLAPPI
University of Texas at Austin

INTRODUCTION

This paper is motivated by a puzzling observation. Over the past decade, a variety of large firms and private sector consortia have approached prominent universities and expressed interest in sponsoring particular research laboratories. In return for their sponsorship, these organizations have requested that all inventions generated by the sponsored labs be licensed openly, on a *non-exclusive* basis only. Why non-exclusive? At first glance, this seems surprisingly generous – in fact, altruistic. Hence, the puzzle.

Consider three examples: 1) Kodak sponsors research in areas related to digital photography; 2) AT&T sponsors research in areas related to communication, including Internet telephony; 3) A consortium, comprised of several of the world's largest pharmaceutical firms, sponsors research related to the Human Genome Project. In each case, the sponsorship stipulates no exclusive licensing. Why would the sponsoring firms choose to disallow exclusive licensing - which has been the norm at universities since the Bayh-Dole Act of 1980[1] - especially since these firms would be prime candidates for licensing the inventions themselves?

One hypothesis is simply that sponsoring firms are worried that competing firms might obtain the exclusive license first. This is certainly a reasonable explanation, but not altogether consistent with the evidence. Historically, sponsoring firms have enjoyed favorable information advantages regarding the research outcomes of the labs they sponsor since they often receive interim briefings prior to publications or conference presentations. So, in practice, they are usually 'first in line' for any related exclusive licenses.

In this paper we explore a second, less obvious, explanation. The hypothesis modeled here is that firms request non-exclusive licensing regimes in order to *prevent*, or at least slow down, the commercial development of inventions in a particular technological market. In other words, firms sponsor research in a laboratory specifically because they wish to retard the development of particular areas of innovation. They purposely spoil the incentives to develop and commercialize inventions from the sponsored lab by creating a market failure. Sponsoring firms accomplish this by creating an intellectual property 'commons' under which no firm is able to obtain exclusive property rights.

Why would firms do this? Under some conditions, if a new market (based on a new technology) is related to an existing market in such a way that the former will cannibalize the latter, it may be profitable for an entrant to develop the invention but harmful for the incumbent to do so. In other words, the incumbent's profits in the original market will be reduced if an entrant develops

the invention or even if the incumbent itself does so. From this perspective, one can imagine reasons why Kodak may want to delay the development of digital photography, AT&T the development of Internet telephony, and large pharmaceutical firms the development of processes for human gene mapping.[2]

Under this threat of cannibalization, one might question why the incumbent doesn't license the patent and leave the technology dormant? The answer lies in the licensing contract that is hand-crafted for each agreement. Benchmarks, milestones, expenditure commitments, and other timeline components associated with product development and commercialization are specified in the contract. Technology licensing officers refer to these contractual conditions as 'use it or lose it' clauses that ensure that the mandate of the university is reflected in the conditions of the contract.[3] Indeed, anecdotal evidence suggests that the incidence of the strategy of the commons is positively correlated with an increase in the sophistication of the 'use it or lose it' contractual terms, both of which have varied across research organizations. In any case, licensing university inventions and not developing them no longer appears to be a feasible strategy for mitigating the effects of cannibalization.

The idea of market cannibalization has been well studied. Arrow (1962) explicitly discussed the 'replacement effect' and argued that a monopolist incumbent would have a lower willingness to pay for an innovation than an entrant since the incumbent would be concerned about replacing its sunk assets and thus have, relatively, less incentives to innovate. Since Arrow, many other scholars have examined particular economic effects of market cannibalization. For example, Abernathy and Utterback (1978) compare incremental and radical innovation and offer a number of reasons, including cannibalization, to explain why radical innovation is typically carried out by entrants rather than incumbents. Foster (1986) popularized the concept of the S-curve for technologies, the shape of which is defined by the increase in performance relative to the development effort expended. Discontinuities in the curve represent new technologies that are often developed by entrants because they have the potential to cannibalize the existing product market.

Gans and Stern (1997) model the allocation of rents from innovation amongst incumbents and entrants that is dependent on the existence and terms available on the 'market for ideas' and use this framework to consider the way in which cannibalization affects the underlying incentives for either firm to conduct R&D. Finally, Christensen (1997) examines the concept of 'disruptive' technologies in a number of product markets, most notably the disk drive industry. In this analysis, cannibalization is once again offered as a primary explanation for development by entrants but not incumbents.

THE MODEL

Here we describe a simple game-theoretic model that we use to investigate the conditions under which it is possible to observe the 'strategy of the commons' as a result of profit-maximizing behavior of players in the licensing game. While a brief outline of the model follows, a complete description of how the model is developed is provided in the full version of the paper.

At the beginning of the game, a sponsoring firm selects a licensing regime for the invention that will potentially be generated. We refer to this firm as the *incumbent*. We assume the incumbent firm has monopoly power in the original market in which it operates (the 'old' market). The incumbent, when sponsoring university research, can decide to select either an exclusive or a non-exclusive licensing regime for the inventions that will be the basis of the 'new' market.

An exclusive licensing regime is one under which only one firm may license the right to use a patented technology at any given time. This also includes technologies that are protected by copyright, trademark, and other forms of legal intellectual property protection. This is in contrast to a non-exclusive licensing regime under which more than one firm may simultaneously license the right to use a protected technology. For the sake of clarity and simplicity, issues such as sub-licensing and restricted fields of use are not considered here. The main implication that arises from the exclusivity distinction in licensing regimes is with regard to competition. In the exclusive case, the licensee firm maintains a monopoly of the technology, whereas in the non-exclusive case, the licensee firm faces either direct competition or at least the threat of competition from other firms.

For exigency of tractability we assume that there exists only one potential entrant in the new market. The resulting game is hence a two-player game in which an established incumbent and a potential entrant interact in the adoption of a new technology.

The two firms are equally efficient in the utilization of the new technology, which is used to develop a product that is a partial substitute for the one already produced by the incumbent. The degree to which the new product is a substitute (degree of cross-price elasticity) for the old product is in fact a key ingredient in the model. This determines the level of cannibalization, which directly affects the incumbent's payoffs since the incumbent holds a monopoly in the old market.

Throughout the analysis we also assume that patents are enforceable and cannot be 'invented around.' This means that a firm must license the patent in order to produce the new technology product. In other words, firms must engage in the licensing game in order to compete in the new market.

The dynamics of the game are summarized in Figure 1. If the incumbent selects an exclusive licensing regime, then both firms decide simultaneously whether or not to license. This is because at most only one firm may obtain rights to the license. In the non-exclusive regime, the licensing decisions are modeled as a sequential game with the entrant moving first since it is possible for both firms to have licensing rights to the invention simultaneously.

Figure 1 about here

It is important to note that the order of the sequential non-exclusive licensing subgame produces an outcome that is the same as that which would result if the subgame were infinitely repeated, with no specified order. In the infinitely repeated game, the entrant is always faced with the threat of subsequent entry by the incumbent. Therefore, what is critical is not which player is allowed to move first, but rather which player is allowed to move second. The incumbent is only

able to threaten the entrant with entry if she is able to license after the entrant has already done so. In other words, the conditions under which the incumbent will play the strategy of the commons are the same in the infinitely repeated game, in which the incumbent can always respond to the entrant's move, as they are when the order of play is dictated as 'entrant first,' as is modeled here.

The 'strategy of the commons' outcome occurs when the incumbent selects a non-exclusive licensing regime and, in the ensuing sequential game, both the entrant and the incumbent decide optimally not to invest in the license, *even though* the new technology would be profitable under an exclusive licensing regime.

The payoffs are generated by deriving industry equilibrium profits drawn from a simple downward sloping linear demand function. While we do not describe the payoffs in this summary version of the paper, we offer some basic intuition. There are three types of outcomes in the new market: 1) no firms enter, 2) one firm enters, or 3) both firms enter. Each outcome in the new market has a distinct effect on the incumbent's profits in the old market. If no firms enter, the old market is not cannibalized. If both firms enter, the old market is cannibalized to a greater degree than if just one firm enters the new market. The incumbent firm maximizes total profits (new market plus old market), while the entrant only maximizes profits in the new market. The competition that results, under a certain set of conditions that depend on the size and profitability of the new market relative to the old market as well as the degree of cannibalization, leads the incumbent firm to play the strategy of the commons. These conditions are described in the following section.

THE STRATEGY OF THE COMMONS AS AN EQUILIBRIUM SOLUTION

The strategy of the commons occurs when the entrant would enter in an exclusive licensing regime but the incumbent selects a non-exclusive regime such that it may credibly threaten the entrant with entry, ultimately deterring the entrant from entering. The 'social' outcome is therefore a situation in which, despite the potential profitability to the entrant, neither firm optimally decides to invest in the license and the invention is not put into use.

In the paper we derive conditions under which the strategy of the commons can emerge as a subgame perfect equilibrium. Three conditions must be met in order for the strategy of the commons to emerge.

- Condition 1 (Exclusive Regime)
  The payoffs in the exclusive regime are such that the entrant *will* invest in the development of the new technology and enter the new market.

- Condition 2 (Non-exclusive Regime)
  The payoffs in the non-exclusive regime are such that the entrant *will not* enter. This is because the incumbent utilizes its option to move second in the sequential game (second mover advantage), allowing it to credibly threaten the entrant. If the entrant doesn't enter, neither will the incumbent, who will continue to enjoy a monopoly in the old market that remains non-cannibalized. However, should the entrant enter, the incumbent

has the incentive to enter as well. As a result, the entrant will not enter because its payoff as a duopolist does not meet the entry threshold.

- Condition 3 (Regime Selection)
  The incumbent's payoffs are such that, given the outcomes of the second stage of the game, the incumbent will select the non-exclusive licensing regime in the first stage. As a result, the potentially welfare-generating innovation is left undeveloped.

In the full version of the paper, we show that there exists a subgame perfect equilibrium in the licensing game in which the strategy of the commons is played. We also examine welfare implications.

CONCLUSIONS

The results of this research suggest some interesting and important strategy and policy implications. From a *strategy* perspective, incumbents may consider ways by which to diffuse potential threats from technology fields likely to produce 'disruptive' innovations. One such way is to create a market failure by dismantling the legal architecture that offers the intellectual property protection that is often critical to entrants for purposes of raising capital and attracting early adopters. In fact, in many cases it is considered necessary for entrants to acquire a 'thicket' of related patents around the key patent in order to instill the required confidence in early stage investors. This implies that the strategy of the commons does not require the incumbent to sponsor *all* research in a particular area to be effective, only enough to prevent an entrant from obtaining *all* of the exclusive intellectual property rights to a potentially threatening substitute. In most cases, a tightly protected intellectual property position is significantly more important for an entrant than for an incumbent.

From a *policy* perspective, governments and university administrations may consider whether particular areas of technical research should be protected from incumbents playing the strategy of the commons. In other words, public sector officials may consider some areas of technological innovation particularly likely to produce 'disruptive' technologies that might not be developed by incumbent firms but would likely be developed by entrants. In most cases, these will be technologies that will enable products that have significant cannibalization effects (high cross-price elasticities with existing products). In these cases, protection of the legal architecture that establishes private intellectual property rights might be considered.

ENDNOTES

1. The Bayh-Dole Act (Public Law 96-517) assigned ownership and control of patents derived from federally funded research to performing institutions, rather than the sponsoring federal agency. Most relevant to this study, it granted non-profit organizations the right to offer exclusive licenses, a right that, as the Columbia University Technology Licensing Office describes, "provided the incentives for the venture capital industry to invest in unproven technology [...]. The results have been dramatic. A trickle of university patents, 200 in 1980, has turned into a flood - now more than 3,000 applications a year" (Winter, 1998).

2. The latter example refers to the SNP Consortium, which consists of several large pharmaceutical rivals including Novartis, Glaxo Wellcome, Pfizer, and SmithKline Beecham. This consortium was formed in 1999 for the sole purpose of sponsoring public-sector research to identify and patent SNPs (Single Nucleotide Polymorphisms) in order to prevent smaller biotechnology firms from entering and obtaining exclusive rights to this genetic information (*The Wall Street Journal* (03/04/1999), *US News & World Report* (10/18/99), *The Economist* (12/04/99)). SNPs are differences in the DNA of individuals that are likely to be important in tracking the genetic causes of disease.

3. The mandate of most research universities, with respect to patent licensing, is to promote the development of their inventions rather than to maximize profits. For example, the MIT Technology Licensing Office states that "in our technology licensing endeavor, MIT is following the mandate of the US Congress when it gave universities title to inventions developed with federal funds: We use licenses to our intellectual property to induce development of our inventions into products for the public good" (MIT TLO promotional pamphlet, 1996).

References Available From the Author

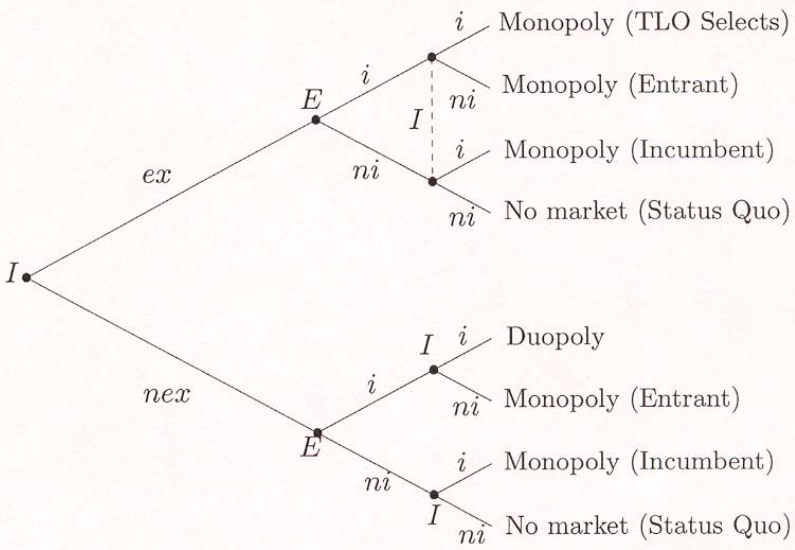

Figure 1: **Dynamics of the licensing game.** E indicates the entrant, I the incumbent; ex represents the exclusive licensing regime, nex the Non-exclusive licensing regime; i indicates the decision to invest in the license and ni the decision not to invest in the license.