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Private Agreements for Coordinating Patent Rights: The Case of Patent Pools

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Abstract

Inventors and users of technology often enter into cooperative agreements for sharing their intellectual property in order to implement a standard or to avoid costly litigation. Over the past two decades, U.S. antitrust authorities have viewed pooling arrangements that integrate complementary, valid and essential patents as having pro-competitive benefits in reducing prices, transactions costs, and the incidence of legal suits. Since patent pools are cooperative agreements, they also have the potential of suppressing competition if, for example, they harbor weak or invalid patents, dampen incentives to conduct research on innovations that compete with the pooled patents, foreclose competition from downstream product or upstream input markets, or raise prices on goods that compete with the pooled patents. In synthesizing the ideas advanced in the economic literature, this paper explores whether these antitrust concerns apply to pools with complementary patents and, if they do, the implications for competition policy to constrain them. Special attention is given to the application of the *U.S. Department of Justice-Federal Trade Commission Guidelines for the Licensing of Intellectual Property (1995)* and its companion *Antitrust Enforcement and Intellectual Property Rights: Promoting Innovation and Competition (2007)* to recent patent pool cases.

Keywords: patents, patent pools, intellectual property
Jel: O31, O34

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When the background legal principles threaten to waste resources, people often rearrange rights sensibly and create order through private arrangements. (Heller and Eisenberg, 1998)

I. Introduction

Since 1982, changes in the U.S. patent office, a restructuring of the courts, and an expansion of intellectual property rights to new product areas have made patents easier to acquire and enforce in the United States. An explosion of litigation activity followed these changes, as patent and copyright holders exercised their intellectual property (IP) rights against alleged infringers. The threat of litigation has been acute in several technological areas – consumer electronics, semiconductors, telecommunications, software, business methods and biotechnology – where new products typically improve upon or require the use of existing patents.[1] To avoid legal suits, developers of these products entangled in a "patent thicket"[2] have had to negotiate with multiple patent owners, stacking up royalty obligations in the process, or abandon R&D on the innovation altogether.[3] These developments over the past few decades have led some economists and legal experts to conclude – contrary to conventional belief – that the strengthening of patent rights has frustrated, rather than supported, incentives to innovate.[4]

[1] See, for example, Lanjouw and Lerner (1998), Lanjouw and Schankerman (2001) and Hall and Ziedonis (2001) for empirical studies of the enforcement of IP rights.

[2] A patent thicket arises when there are overlapping patent rights that must be identified and licensed in order for an innovator to bring a new product or technology to market (Shapiro, 2001).

[3] This situation, referred to as the "tragedy of the anti-commons" (Heller and Eisenberg, 1998), occurs when too many individuals have fragmented rights on a scarce resource, thereby resulting in its underutilization (in contrast to the "tragedy of the commons" in which too many individuals have open access to a commonly-owned good).

[4] In the early literature, innovations were modeled as stand-alone inventions for which the relationship between IP protection and incentives to research was positive. For more complex innovation processes, Kitch (1977) notes the positive role of IP in providing "prospect" incentives to explore multiple research paths and increase the probability of success. However, when innovation is sequential in new ideas building upon previous generations – typical of modern technologies – this positive relationship between IP strength and incentives to research may break down. Introduced by Scotchmer and Green (1990) and Scotchmer (1991), the sequential innovation paradigm is the theoretical basis of studies calling for significant patent reform (e.g., Bessen and Meurer (2008); Jaffe and Lerner (2008); Boldrin and Levine (2009)) that range from improving the examination process to strengthening the non-obvious standards to outright abolishment of the patent system as it currently exists. Empirical papers have made creative strides in measuring the impact of patent strength on innovation (see for example, the review in Gallini (2002) and the references therein, Lerner (2002,2009), Evanson and Kanwar (2003)) and theoretical papers

Fortunately, patentees also engage in productive exchange by participating in multi-lateral arrangements for sharing their technologies, thereby circumventing the costs of lengthy court challenges. Cross-licensing agreements, for example, facilitate the exchange of portfolios of patents between owners of intellectual property (IP).[5] Alternatively, where several patents are essential for meeting a standard, firms may agree to pool their patents and coordinate licensing of their combined technologies to each other and third-party users (*e.g.,* MPEG-2, DVD ROM and DVD Video standards).[6] Similarly, IP clearinghouses and copyright collectives (such as the American Society of Composers, Authors and Performers), which collect information, engage in advocacy or monitor usage, also can reduce transaction costs of search and selection among available IP options.[7]

This paper focuses on patent pools that antitrust authorities view as having "pro-competitive benefits by integrating complementary technologies, reducing transaction costs, clearing blocking positions, and avoiding costly infringement litigation,"[8] that is, agreements which mitigate the anti-commons problem arising from the fragmentation of IP rights.

Since patent pools are cooperative agreements, they also have the potential of suppressing competition if, for example, its members harbor nonessential, weak or invalid patents. Moreover, when the pool supports a standard, network externalities can turn IP into an effective instrument for leveraging control on products outside of the pool or the sharing of patents can dampen incentives to

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have analyzed alternative mechanisms for encouraging R&D (e.g.,Wright (1983), Kremer (1998), Shavell and van Ypersele (2001), Gallini and Scotchmer (2002) and Bessen and Maskin (2009)).

[5] For example, see Fershtman and Kamien (1992) and Arora et.al. (2001) for an analysis of cross-licensing and other forms of licensing in technology markets.

[6] Other licensing restrictions also might be used to resolve disputes; for example, grant-backs (the requirement that a licensee agrees to license all future improvements), tying (licensing a patented technology with another patented or unpatented product), exclusivity (licensing a technology to only one licensee or requiring the licensee to deal with only the licensor), non-assertion clauses (commitment not to assert IP rights against contracting parties) and research joint ventures.

[7] For example, see Merges (1996) and Aoki and Schiff (2008) for a discussion of institutions for coordinating intellectual property rights and an analysis of market mechanisms that give rise to these institutions.

[8] Section 5.5 of the *U.S. Guidelines (1995).* The Guidelines acknowledge the problem that arises when owners of complementary inputs do not internalize the impact of price increases on the demand for other inputs and therefore set prices higher than is socially and privately efficient. Coordinated control of the inputs through a merger or patent pool can potentially remedy the problem.

conduct research on innovations that compete with the pooled patents. Whether or not these antitrust concerns apply to pools with complementary patents is explored in this paper.

More broadly, the paper synthesizes the ideas advanced in the economics literature that contribute to our understanding of the efficiencies and potential anticompetitive effects of these cooperative agreements.[9] Section II provides a brief review of some prominent court cases as well as a discussion of the *U.S. Department of Justice-Federal Trade Commission Guidelines for the Licensing of Intellectual Property* (1995) (hereafter, the *Guidelines*) and its companion *Antitrust Enforcement and Intellectual Property Rights: Promoting Innovation and Competition (2007)*. Approaches for implementing the *Guidelines,* as they apply to patent pools, are presented in Section III. Section IV explores potentially anti-competitive effects of patent pools identified in the economics literature. Section V concludes with an evaluation of the recent approach adopted by the U.S. Department of Justice and directions for further research.

II. History of Antitrust Toward Patent Pools

This section provides some highlights of the history of antitrust decisions regarding patent pools in the United States.[10] Starting with *Bement & Sons v. National Harrow (1902)*[11] and continuing for a decade, patent laws tended to eclipse antitrust laws. In this landmark case, twenty-two firms with 90% of manufacturing float spring tooth harrows transferred their patents to a holding company, National Harrow. They jointly licensed their patent portfolios, fixed prices and required licensees not to deal with

[9] The literature on patent pools has grown substantially over the past decade. See for example Shapiro(2001), Aoki(2004), Aoki-Nagaoka (2004), Aoki-Schiff (2007,2009), Gilbert (2004,2009), Lerner-Tirole (2004), Kato (2004), Kim (2004), Lerner-Strojwas-Tirole (2007), Choi (2005,2010), Dequiedt-Versaevel(2006), Brenner(2008), Layne-Farrar and Lerner (2008), Lampe-Moser(2010a,b), Baron-Delcamp (2011), Delcamp (2011), Gallini (2011) and Lévêque-Ménière (2011).

[10] See Gilbert (2004) for a comprehensive review.

[11] *Bement v. National Harrow Co.,* 186 U.S. 70 (1902).

products outside the pool or to challenge patents in the pool. Nevertheless the Supreme Court concluded that:

"…the general principle is absolute freedom in the use or sale of rights under the patent laws of the United States. The very object of these laws is monopoly, and the principle is, with few exceptions, that any conditions which are not in their very nature illegal…imposed by the patentee and agreed to by the licensee…will be upheld by the courts."[12]

The "absolute freedom" patentees were granted to coordinate activities through patent pools ended by the second decade of the 1900s. A new, harsher view was adopted by the courts and continued, although unevenly, beyond the mid-1900s. A prominent example is the decision in *Hartford-Empire* (1945)[13]. Controlling over 600 product and process patents in the manufacture of glassware, the Hartford-Empire pool dominated 94% of the product market in the United States and imposed several restrictions on the licenses to its members. The District Court found that antitrust concerns trumped patent rights in this case:

"It is said on behalf of Hartford that. . .in order to protect its legitimate interests as holder of patents for automatic glass machinery, it was justified in buying up and fencing off improvement patents, . . .The explanation fails to account for the offensive and defensive alliance of patent owners with its concomitant stifling of initiative, invention, and competition."[14]

In contrast to *Hartford-Empire*, the facts in *United States v. Line Material* (1948)[15] suggest a relatively benign impact on competition, but this case was dealt with no less sharply by the Supreme Court. The Line Material patent pool, which included Southern's basic patent and Line Material's improvement, is an example of "one-way blocking." Line Material received an exclusive license on the basic patent and, therefore, the power to set prices under both patents. Although the Court recognized that cross licensing could promote efficient production ("…only when both patents could be lawfully

[12] *Id.* at 91.
[13] *Hartford-Empire Co. v. United States,* 46 F Supp 541 (N.D. Ohio 1942), 323 U.S. 386 (1945).
[14] *Id.* at 407.
[15] *United States v. Line Material,* 333 U.S. 287 (1948).

used by a single maker could the public…obtain the full benefit of the…inventions"), it nevertheless concluded that:

> "*the agreement between Southern and Line for Line's sublicensing of the Lemmon patent was to combine in Line's hands the authority to fix the prices of the commercially successful devices embodying both the Schultz and Lemmon patents. . . A contract to fix or maintain prices…has long been recognized as illegal under the Sherman Act.*"[16]

Antitrust concerns remained paramount.

This very issue of explicit price fixing was the factor distinguishing *Line Material* from the earlier *Standard Oil* case (1931). The Supreme Court, in reversing a district court finding that Standard Oil's patent pool was illegal, acknowledged that cross licensing of blocking patents could bring social benefits. In *Line Material* it too recognized that "there is nothing unlawful in the requirement that a licensee should pay a royalty to compensate the patentee for the invention and the use of the patent", but on the other hand disapproved the "use of the control that such cross-licensing gives to fix prices."[17] The Court did not recognize, however, that a royalty could generate the same outcome as price fixing, thus rendering the distinction between royalty arrangements and cross-licensing inconsequential. In this case, the Court's ruling may have prevented an efficient patent sharing arrangement.

By the 1980s the pendulum began to swing back and settle on a more moderate stance. As articulated in the *Guidelines* (1995), patent licenses have been viewed more recently as generally pro-competitive unless it can be shown that competition has been reduced relative to that which would have occurred absent the agreement.[18] This doctrine, extended from licensing agreements to patent pools, has permitted pools and similar organizations comprising components that are *complementary,*

[16] *Id.* at 291 and at 307.

[17] *Id.* at 315.

[18] Not all patent pools have passed the test set out in the *Guidelines.* For example, a pool between two companies, Summit Technologies and Visx, each claiming to hold essential patents for the manufacture of laser eye surgery machines, was forced to dissolve in 1998 since the FTC noted that the two firms would have been competitors in the market for equipment that used their respective patents.

valid and essential in order to satisfy standards for production and use of downstream products.[19] Examples include pools formed to implement the MPEG video and audio data compression standards, DVD-Video and DVD-ROM standards and the 3G mobile platforms.[20] In these cooperative agreements, each firm's patents cover a small but essential component, the collection of which is necessary to develop new products; licensees are free to use alternative technologies; and the pooled patents can be licensed both individually and as a bundle. We turn now to an economic analysis of this view articulated in the *Guidelines* and its implications for the design of welfare-improving patent pools.

III. Implementing the Guidelines: The Product and Litigation Rules

As noted in the previous section, the more recent approach for evaluating patent pools, advanced in the *Guidelines*, balances the rights of IP holders with the benefits of competition. Precisely what this implies about the characteristics of permissible patent pools is examined in this section. Two approaches for identifying welfare-enhancing patent pools, referred to as the *Product Rule* and the *Litigation Rule* in this paper, are presented and compared.

A. The Product Rule

Throughout the history of antitrust, the nature of restrictive licensing terms (*e.g.,* resale price maintenance, exclusive territories, non-compete clauses) has been a primary focus in the evaluation of potential antitrust violations of patent pools. The *Guidelines* shifts the focus to the determination of potential harm to competition among pool members "that would have been actual or potential

[19] A component is essential if it is technically required and has no close substitutes; that is, anyone implementing the standard it supports would necessarily infringe the patent. (Gilbert, 2009)

[20] Gaulé (2006) notes that pool formation is less common in the biomedical area and pharmaceuticals; however, in 2009 GlaxoSmith Kline introduced a patent pool for combating neglected diseases and UNITAID recently approved an agreement to open a Medicine Patent Pool foundation (see Gold, et.al. 2007).

competitors" outside of the agreement.[21] Restating this principle, Gilbert (2004) suggests *"antitrust evaluations should begin with a study of the competitive relationships of patents involved in the pool."* This approach for assessing patent pools will be referred to here as the *Product Rule*.

In assessing the impact of the competitive relationship among patents, the polar cases are straightforward: A patent pool with perfect complements that are essential (i.e., technically-required with no substitutes) would be viewed favourably since coordinated pricing leads to lower prices and higher surplus relative to no pool, whereas pools of substitutes without any redeeming features would be suspect. While the polar cases provide a useful benchmark, in practice, cases of perfect complements or substitutes are rarely observed. More commonly, the relationship between patents in a pool includes elements of both substitutability and complementarity, confounding the distinction between agreements that are beneficial versus anticompetitive.[22] Misdiagnosis of a pool as consisting of essential complements when in fact it contains nonessential substitutes is a risk especially in the early stages of an industry (Lanjouw and Lerner (2001)).

"Two-way blocking" – a situation in which components have value only when used with others to create a new product (e.g., as in the MPEG-2 protocol) – approximates the "perfect and essential complement" abstraction. Others, such as "one-way blocking" in which sales of an improvement can be blocked by a basic patent (e.g., as in Line Material), are more ambiguous since the products are both substitutes and complements: Since the basic and improved products are imperfect substitutes, the relationship between firms is horizontal and it is also vertical (and complementary) because the basic patent is an input into the production of the improvement.

Reflections on *Line Material* provide insights on the latter, more ambiguous case. Following Gilbert (2004), consider a simple framework in which a basic patent and improvement are valued at v_1

[21] *Guidelines,* Section 5.5, Example 10.

[22] See Lerner and Tirole (2004) for an analysis of this issue in which the full range of products from perfect substitutes to perfect complements is considered.

and v_2, respectively, $v_2 > v_1$. If the firms are allowed to form a pool, they will agree to sell the improvement at a price of v_2 and split the profits. Now suppose they are not allowed to enter a pool but firm 1 can offer a royalty-licensing contract. If firm 1 withdraws from the market, it will set a royalty $R = v_2$ and capture the full surplus[23] or, alternatively, if firm 1 refuses to license, consumers will receive only the basic invention and generate v_1 revenues to firm 1, implying that pools of complementary patents can improve upon or achieve the same outcome as the non-cooperative solution.[24] In contrast, a pool of substitutes, with no redeeming features arising from the coordinated effort, would be socially inferior to the competitive outcome. Although stylized, this simple example demonstrates that the nature of the products in the pool matter, thus providing support for the Product Rule in evaluating the welfare implications of patent pools.

B. <u>The Litigation Rule</u>

Under the Product Rule, complementarity is sufficient for a pool to be socially desirable. However, when a private agreement is negotiated in the shadow of actual or potential patent disputes that would occur if not for the agreement, complementarity may not be enough to guarantee a welfare improvement. That is, patent rights are only *probabilistic* in the sense that the right to exclude others from using the patent depends on the uncertain outcome of an infringement or validity challenge.[25] Consequently, consumers may be better off under litigation that invalidates the patents and makes them available at competitive prices, than under a settlement. Noting that this feature of patents should be recognized in antitrust decisions, Shapiro (2003) recommends that:

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[23] If firm 1 is not allowed to withdraw from the market, then P_1 and P_2 will satisfy: $v_2 – P_2 = v_1 – P_1$ or $P_2 = (v_2 - v_1) + P_1$. Since $P_1 \geq R$, the opportunity cost of firm 1 producing, the improvement will win the market if P_2 is set slightly below $(v_2 - v_1) + R$, yielding positive consumer surplus of $v_1 – R$ if $R < v_1$. However, this would not be an equilibrium outcome since firm 1 could earn v_1 by refusing to license.

[24] For elastic demands, they are strictly preferred since double marginalization arising between two vertically-related duopolists is eliminated.

[25] See Lemley and Shapiro (2003) for an examination of probabilistic patents.

"A patent settlement" should not "lead to lower expected consumer surplus than would have arisen from ongoing litigation. This standard…balances the rights of patentees with consumer interests." (p. 396)

The above view is referred to here as the *Litigation Rule.* Note that it calls for protection of both the probabilistic rights of the patentee by ensuring profits that would accrue "under the shadow of patent litigation", and the property right of consumers by ensuring benefits from competition that would otherwise arise from litigation. Under this rule agreements are allowed only if they yield consumer surplus at least as large as in the litigious outcome.[26]

It is straightforward to determine situations under which the Product and Litigation Rules will reach the same conclusions on the welfare effects of patent pools and when they will diverge. First, consider the case of one-way blocking. As noted earlier, if the basic and improvement patent (with respective values v_1 and v_2) are expected to be valid, a simple royalty contract can yield the same consumer (and total) surplus as an agreement in which the firms pooled their patents. Similarly, if the improvement patent were expected to be invalid, then the owner of the basic patent would be able to block the others from using the improvement and sell it at a price v_2 – again, the outcome under the cooperative settlement. Hence, both rules would permit a patent pooling settlement.

If the *basic* patent is expected to be invalid, however, then the two rules could diverge in their recommendations. To see this, suppose the basic patent is sold in a competitive market (after invalidity is established), and P_1 and P_2 are the respective prices of the basic and improved goods. Then P_1 will fall to zero, constraining P_2 to $P_2 \leq v_2 – v_1$ and yielding a consumer surplus of v_1. Unless a patent pool generates the same consumer surplus, it will not be allowed under the Litigation Rule but may be permitted under the Product Rule since the patents are complementary.

The two rules also can be compared in the case of two-way blocking patents. Following the framework in Shapiro (2003), let S_M be the consumer surplus under the pool (or monopoly outcome), S_D

[26] Shapiro shows robust conditions under which firms settle and when it is socially desirable to do so (in that the firms are at least as well off while not harming consumers), noting that 95% of disagreements are settled in the shadow of litigation.

the surplus under the non-cooperative (duopoly) outcome, and S_E the free entry outcome if both patents are declared invalid. Patents are assumed to expire at time 1. If the firms pool their patents immediately, they earn S_M; if they are not allowed to do this, they compete as duopolists until time T when litigation occurs. Each patent is valid with probability θ. If neither or one patent is found to be invalid, then the firms are assumed to settle at the pool/monopoly outcome; otherwise, there is free entry and the competitive outcome ensues. Then, the Litigation Rule favours the patent pool at time 0 rather than the duopoly outcome if:

$$S_M \geq T\, S_D + (1-T)\,(\theta^2 + (2\theta(1-\theta)))\, S_M + (1-T)(1-\theta)^2\, S_E \quad \text{or}$$

$$(1) \qquad \frac{S_M - S_D}{S_E - S_D} \geq \frac{(1-T)\,(1-\theta)^2}{T+(1-T)(1-\theta)^2}$$

Consider two polar cases: Litigation never occurs (T = 1) and litigation is immediate (T = 0). In the first, when T = 1, (1) implies that the pool should be approved if:

$$(2) \qquad S_M \geq S_D$$

For complementary components, coordinated pricing dominates the duopoly outcome since price effects are internalized, thereby satisfying (2). Again, the Product and Litigation approaches reach the same conclusion.

Next consider the other extreme in which litigation occurs immediately: T = 0. A settlement or cooperative agreement (e.g. patent pool) is preferred to litigation if:

$$(3) \qquad S_M \geq S_E,$$

Since (3) does not hold for the conventional case of complements (or substitutes for that matter), a cooperative agreement will not be allowed under the Litigation Rule if the patents are expected to be contested immediately but may be permitted under the Product Rule if the patents are complementary.

In the above model, the timing of litigation is exogenous. If instead the incentive to litigate depended on patent validity as in Choi (2010), then the two principles may converge. To see this, consider the case of very weak patents (*i.e.,* $\theta = 0$). From (1), a patent pool is socially preferred to competition if: $S_M \geq T\, S_D + (1\text{-}T)\, S_E$. If, however, patentees were not likely to challenge each other in the absence of a pool, then T would effectively be equal to 1, thereby rendering pools with weak, complementary patents harmless. This situation is discussed further in the next section.

At the other end of the spectrum, both rules also appear to favour patent pools with valid patents (*i.e.,* θ is close to 1).[27] To the extent that validity is correlated with "patent strength"[28], this suggests that these rules support an antitrust policy that is more lenient toward cooperative agreements when patents are stronger, that is, an antitrust policy that reinforces rather than constrains patent rights. However, this relationship may not hold if consumer surplus incorporates dynamic as well as static measures of market conditions. In particular, incentives to engage in future research may be greater in a non-cooperative setting, potentially generating a larger surplus for consumers, than under a patent pool. Determining whether that is the case would require an analysis of the "innovation market", a concept advanced in the *Guidelines* and defined in Section 3.2.3 as "research and development directed to particular new or improved goods or processes, and the close substitutes for that research and development", which include R&D efforts, technologies and goods that "significantly constrain the exercise of market power with respect to the relevant research and development." As acknowledged in the *Guidelines,* identifying when arrangements may "affect the development of goods that do not yet exist" or "where there is no actual or likely potential competition in the relevant goods" is difficult at best. This potential dampening of incentives to innovate under a patent pool and other anticompetitive concerns are examined further in Section IV.

[27] If θ=1, then the inequality in (2) holds.

[28] For example, in Farrell and Shapiro (2008), patent strength is defined as the probability that a patent is found "valid and infringed" if contested in court.

IV. Potentially Anticompetitive Features of Patent Pools

Under the Product and Litigation Rules described above, pools with valid and complementary patents are typically welfare enhancing. However, this result is based on a simple static framework in which the decisions to litigate, vertically integrate and innovate are either exogenous or not considered. In more complex environments, patent pools – even those combining complementary patents – can have negative welfare consequences if, for example, they reduce incentives to challenge weak patents, foreclose competition in downstream markets or discourage innovative activity. This section explores these potentially anti-competitive consequences of complementary pools along with their implications for competition policy.

A. Protecting Weak Patents

The potential for patent pools to harbor weak patents as an entry-deterring strategy has been a concern in antitrust cases. For example, according to the Court in *Duplan Corp. v. Deering Milliken Inc.* (1977) [29], the patentees were well aware that their patents were weak and entered the agreements (involving licensing restrictions) in order to prevent challenges to patent validity. Since "a weak patent is a threat to every patent" (Gilbert (2004)), competing firms will have the incentive to enter into an agreement with the purpose of jointly defending weak patents. In contrast, for complementary patents, only one valid patent is needed to preserve the cooperative outcome and so there is less incentive to jointly protect weak patents.

While incentives to defend weak complementary patents are muted, so too are incentives to contest them; that is, patentees tend to follow a "live and let live" strategy, identified by Choi (2005,

[29] 444 F. Supp 648, 682 (D.S.C. 1977).

2010). In a formal model, he shows that if the litigation decision depends on the probability of patent validity, owners of relatively weak patents will not litigate each other when operating separately. Consequently, a pool under which patentees are expected not to challenge each other would be deemed at least as good as the alternative under the Litigation Rule. Moreover, since third parties generally will not find it worthwhile to challenge weak patents because of the public good nature of doing so, weak patents would be protected at the expense of consumer welfare. Consequently, in arguing for a stricter rule, Choi recommends that third parties be given incentives to challenge weak patents and that pools not be approved before the patents are validated if litigation costs are sufficiently low,[30] which is consistent with current antitrust practice.[31]

B. Foreclosing Downstream Rivals from Market

In determining whether a pool will be inclined to accommodate or foreclose rivals, we introduce competition in upstream and downstream markets. First, consider the downstream market. Suppose a subset of the patentees is vertically integrated, as is characteristic of recently approved pools, and so are engaged in production of both the upstream inputs and downstream final products requiring those inputs.

To determine the welfare consequences of patent pools in this case, Kim (2004) develops a model in which *m* specialized upstream firms produce differentiated components, *s* specialized downstream Cournot firms produce homogeneous products, and *n* vertically integrated firms operate in both sectors. Upstream firms issue separate licenses or a single license for the bundle of components to the downstream firms, including the vertically integrated members of the pool. Two externalities can

[30] For example, under the Hatch-Waxman Act (*The Drug Price Competition and Patent Term Restoration Act*, 1984) for pharmaceuticals, successful challengers are given an exclusive right to the generic market for 180 days.

[31] Farrell and Shapiro (2008) also argue that approving weak patents could have significant *ex ante* and *ex post* negative consequences and therefore should be subject to post-grant review.

lead to inefficient pricing: (1) the complements problem and (2) raising rivals' costs, as analyzed by Salop and Scheffman (1983) and Ordover, Saloner, Salop (1990). Potentially softening the impact of these externalities is the elimination of double marginalization by those firms that are vertically integrated. In this framework, foreclosure occurs in equilibrium; that is, the vertically integrated firms have an incentive to raise prices sufficiently high to eliminate all downstream non-integrated firms. This stark result would not likely arise in a more general model with differentiated downstream firms but it is nevertheless useful for comparison with coordinated pricing examined next.

Under a pool in which the upstream firms coordinate their input prices, the participating firms internalize both the impact of raising their prices on the demand for the other inputs in the pool (effect in (1) above), which causes prices to fall relative to no pool, and on the downstream profits of the vertically integrated pool members. Since prices fall under a pool, foreclosure is reduced and welfare increases with coordinated pricing.[32] Although there is partial foreclosure, since integrated firms effectively face lower royalty rates relative to that paid by non-integrated firms, the negative impact is expected to be less under a pool than in its absence.

Next consider competition in the upstream input market. That is, differentiated substitutes for one or more of the pooled inputs exist, effectively rendering them non-essential. If the patents in the pool are bundled, including those with alternatives outside the pool, then competing input firms may be foreclosed from the market. Such foreclosure can be avoided either by requiring that all patents included in a pool be essential or that members be allowed to license their patents independently as well as part of a bundle. Although essentiality and independent licensing are substitutes for arresting foreclosure, both features have been required for approval. Practically, they are not perfect substitutes since independent licensing is easier to observe than essentiality and, as shown by Lerner and Tirole

[32] While the results in Kim (2004) and Lerner and Tirole (2004) differ in the impact of vertical integration on the price of the downstream product, they both show that under vertical integration, pools will increase welfare for complementary patents (more precisely, if the demand margin binds in the absence of the pool).

(2004), independent licensing can serve as an effective screening mechanism since it will typically not be found in welfare-decreasing pools.[33]

C. Reducing R&D Incentives in the Upstream Innovation Market

In this section we ask whether a pool dulls incentives to invent around rivals' patents or to discover new technologies related to the pool. As shown in Lerner and Tirole (2004), prospective members have enhanced incentives to innovate prior to joining a pool. In fact, R&D may be excessive in the initial period of pool formation since it pays to be an early entrant (Dequiedt and Versaevel (2006)) but then declines after the pool is established.

In contrast, e*x post* incentives may be dulled if inventions developed later must be automatically assigned to the pool. But even if incentives to develop (relatively high-cost) inventions in the future are compromised by this provision,[34] automatic assignment may increase welfare by preventing hold-up and thereby encouraging firms to join efficient pools in the first place (Lerner and Tirole (2004)). Reinforcing this may be a replacement effect from coordination, as identified by Arrow (1962), in which the pool's incentives to innovate (replace itself) are dulled relative to a more competitive environment.

Moreover, free-riding may discourage research by pool members (Aoki and Nagaoka (2004)): After an industry standard is agreed upon and facilitated by a pool, firms with essential inputs may have the incentive to free ride, either by defecting or not joining the pool. While increasing its profits by producing independently, a defecting patentee will reduce total profits to the pool and, therefore,

[33] When patentees are allowed to sell their components separately as well as in a bundle, prices are constrained for welfare-reducing pools but not welfare-increasing pools; consequently, independent licensing is unlikely to be observed in the former case. Extending the Lerner-Tirole framework, Brenner (2009) shows that in fact such a mechanism is effective in destabilizing welfare-reducing pools only if patentees are allowed to exclude rivals from entering the pool.

[34] Mullen and Sicalides (2001) discuss ways to alleviate this concern, which include giving greater weight to newer innovations in the royalty formula; allowing grant-back provisions to be non-exclusive; and calculating royalties on the basis of the actual use of the patents.

members' incentives to improve the quality of the standard through R&D. Of greater concern is the destabilizing effect that free-riding may have on efficient patent pools, a situation that worsens with patentee heterogeneity and with allocation rules that divide profits equally or according to the share of patents contributed to the pool.[35]

In summary, the following predictions emerge from the literature regarding the impact of patent pools on R&D activity:

(1) *Ex ante* to pool formation, prospective pool members will overinvest in R&D leading up to the formation of the pool, followed by a decline in innovation activity after the pool is formed.

(2) *Ex post* pool formation, patentees have the incentive to free ride on the standard, which reduces profits and incentives to research, particularly when firms are heterogeneous and equal profit-sharing rules or automatic assignment are in effect. Potentially countering these negative effects are cost savings from reduced litigation among members of the pool and access to discoveries generated by the pool.[36]

Lampe and Moser (2010a) test these predictions for the sewing machine patent pool of the 19th century (1856-1877). The pool included complementary patents that were essential for the superior (lockstitch) technology. Members of the patent were free to license their components independently as well as in the bundle; in fact, licensing was encouraged through low royalty rates that dropped

[35] In particular, members may be heterogeneous in their pool activities, with some focusing on research only and others integrated into downstream markets. Furthermore, Lévêque and Ménière (2011) show that hold up and pool instability is more likely if licensing terms are negotiated after licensees have already incurred the fixed costs of entry. This discussion is also related to the research joint ventures (RJVs) literature. D'Aspremont and Jacquemin (1988) and Motta (1992) explore cooperative R&D agreements for process innovations and vertical product improvements, respectively, by firms that compete in the downstream market. They show that cooperative R&D leads to higher innovation, output and welfare since technological spillovers are internalized. Similarly Kamien, Muller and Zang (KMZ; 1992) derive favourable results for cooperative RJVs in a model in which R&D efforts are shared and not duplicated whether or not R&D activity is independently or collectively determined. Effective R&D is lower under a competitive RJV, relative to a cooperative one, and in fact, falls below research activity generated under full competition, in which firms compete in R&D and do not share their findings. Here, the patent pool can be interpreted as an RJV in which the combined inputs are similar to coordinated research output that is available to all members, which then compete in the downstream market. Patent pools may engage in either competitive or cooperative R&D, but in most cases the results of the research are available to all members (as assumed in KMZ).

[36] In offering a bundle of components, the pool may also generate a positive demand effect since it reduces the costs to users of negotiating multiple licensing contracts required for the production or use of their downstream products.

significantly throughout the life of the pool. Measuring innovation in two ways (patents and stitches per minute), the authors describe a pattern of innovation with (1) high activity prior to the pool formation; (2) a reduction in R&D activity by both the members and outside firms for the duration of the pool; and (3) an increase in innovation after the pool was dissolved, coincident with patent expiration of the pooled patents.

The empirical results show that outside firms reduced innovative activity while focusing on the inferior (chain stitch) technology. An explanation given in the paper is that the outside firms were responding to litigation threats, which appeared more aggressive during the life of the pool than when the patentees operated separately.[37] Reinforcing this effect may have been the fact that the superior technology simply made the pool members more formidable competitors. That is, developing a better, non-infringing substitute may have been too costly, especially given the availability of the relatively low cost option of licensing the pooled technology.[38]

Regarding R&D activity by the pool members, support is found for the theoretical prediction in (1): that innovation activity was high prior to pool formation and declined thereafter. After the pool was formed, research declined perhaps due to free riding and strategic effects noted above that dampen

[37] Although the pool members may have been more aggressive in the upstream innovation market, they appear to have been less aggressive in the downstream product market. In particular, the authors note that the downstream firms were reasonably accommodated (royalty rates declined over time), although differential royalties were set for insiders and outsiders. This is consistent with the results from the foreclosure literature under vertical integration reported above.

[38] Recent empirical work provides some support for the authors' conjecture that the patentees were more aggressive litigants when in the pool. Examining 1564 essential U.S. patents belonging to 8 different pools, Delcamp (2011) provides empirical support that litigation activity tends to be greater under patent pools than when firms operate non-cooperatively. However, the incentives for a pool to litigate more aggressively are mixed. For example, if a pool consists only of complementary components, then its members should not be threatened by an outside replacement that either invalidates or competes with one or more of the inside components; as long as at least one patent remains valid, monopoly profits can be achieved, whereas in the absence of a pool, the individual patentee being threatened would have greater incentive to litigate. If, however, research by outsiders is expected to lead to a competing standard, then the patentees in a pool will have increased incentives to litigate. Moreover, the incentives for the patentees to license strategically in order to reduce their competitors' incentives to innovate may intensify under the pool. Indeed, the authors report that the pool approved licenses to "all applicants whose machine was 'not an offensive imitation of the machine of some other licensed manufacturer'" (Lampe and Moser, 2010b, p.7). See, for example, Gallini (1984) in which licensing is used strategically to deter competitive innovation.

research incentives.[39] The theoretical and empirical literature has been instructive in identifying drivers which encourage or dissuade research under technology sharing; nevertheless, as the authors emphasize, greater clarity in the testable predictions accompanied by further empirical analysis is required before claims regarding the effect of pooling on research activity can be made with confidence.

D. Softening Competition in Outside Goods

In the previous sections, outside firms affect the benefits and costs of patent pools: They may challenge the validity of the pooled patents (section A); compete in the downstream market (section B); or develop substitute products in the upstream innovation market (section C). In this final subsection, we shift ownership of those substitutes from outside to inside firms. In particular, a member of the pool is assumed here to produce a substitute (or competing standard) for the pooled downstream product as well as one or more of the inputs required for the production of the latter good.

To explore this further, let X and Y be two inputs produced by firms 1 and 2, respectively, and combined in fixed proportions to produce Z, which is sold in a competitive, downstream market. Furthermore, suppose W is a differentiated substitute for Z, also produced solely by firm 1 as shown in Figure 1; that is, Firm 1 have *overlapping ownership* in competing goods inside and outside of the pool.

If the firms operate non-cooperatively, then firm 1 will choose the prices of W and X to maximize its total profits given the price of Y; while Firm 2 chooses its profit-maximizing price of Y given the prices of X and W. In choosing the prices of W and X, Firm 1 internalizes the positive effect that a price increase has on the demand for the other good, thus placing upward pressure on both prices than if W were produced by an outside firm.

[39] The free-riding argument, however, is suspect since there appeared neither to be automatic assignment of future patents nor defection by pool members.

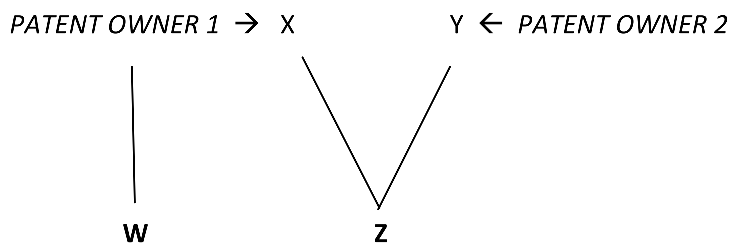

Figure 1

Now suppose the two patent owners pool their components X and Y and coordinate the input prices that maximize total profits of its members, but are constrained by antitrust decree from setting the price of W. Firm 1, as the owner of patents on both X and W, chooses the price of W to maximize its profits from sales of the good and its share of the pooled profits given the price of Z set by the pool. As before, Firm 1 internalizes the effect of an increase in the price of W on sales of Z, but this time taking into account its share of the joint profits from the pool.

In a Bertrand differentiated framework, Gallini (2011) shows that the pool can have the effect of reducing *both* prices of Z and W if the downstream products are strategic complements, regardless of the ownership structure of W (whether it is owned by outside firms or one or more pool members). For the case in which the ownership of a pool member (say Firm 1) is overlapping, the firm internalizes not only its relationship between W and X (as it did when operating non-cooperatively) but also the impact of raising the price of X on the demand for Y. Since the latter are complements, the price of Z falls; and since W and Z are strategic complements, a reduction in the price of Z lowers Firm 1's marginal profit on W and, therefore, the price of W declines.[40] That is, a pool increases competition in the market. But that is precisely why forming an efficient pool may not be incentive compatible. For the case of quadratic utility and fixed-fee transfers, it can be shown that if W and Z are strong substitutes, the profits

[40] The marginal profit from raising the price of W falls with a decline in the price of Z because any additional demand generated from increasing W's price would have a lower value and the output on which the higher price of W is valued is lower in the more competitive environment created by the pool.

generated from sales of Z under a pool may not be sufficient to compensate Firm 1 for its loss in profits on W, holding Firm 2's profit at the no-pool level.

This sketch of pools with overlapping ownership reveals that an increase in coordination between substitutes brought about by the formation of a pool can increase competition in the downstream market, reducing prices of both the final (pooled) product and its outside substitute. [41] However, this result may not hold for strategic substitutes or more complex environments;[42] consequently, antitrust authorities should be circumspect when evaluating competitive relationships between members of the pool. In particular, the Product Rule should be expanded to include an assessment of the relationship between the patentees regarding their products *outside of the pool* as well as their patents *inside the pool*. This is consistent with the message in the U.S. Patent and Trademark Office white paper (2000), which states that: "…pool participants must not collude on prices outside the scope of the pool."[43]

[41] This contrasts with results obtained in Tepperman (2000) which shows that resale price maintenance (RPM) in licensing contracts can be a mechanism for controlling prices of a product that competes with the patented good by giving an exclusive license to the owner of that substitute product. Tepperman shows that for strategic complements, the licensor can extract additional rents through RPM than it would earn by refusing to license, since the licensee internalizes the price of the patented product on the demand for its substitute good when setting the price. In this case, overlapping ownership can have negative welfare effects. The idea outlined above and formalized in Gallini (2011) complements Tepperman's analysis of uni-lateral licensing agreements with price constraints in that the multi-lateral nature of technology sharing agreements and the complementarity between the licensed products present distinct externalities and, consequently, implications for antitrust policy.

[42] For example, if both firms controlled W and Z such that the pooled outcome maximized total industry profits (on W and Z), then for homogeneous substitutes, the firms in a pool would suppress production of one of the products. Such was the complaint in Princo Corp v. International Trade Commission in which Philips and Sony were in a CD-R/RW pool arrangement that supported the standard Raamaker. The patent misuse case, for which they were vindicated, alleged that firms had suppressed another method (Lagadec) on which they held patents.

[43] USPTO (2000), "Patent Pools: A Solution to the Problem of Access to Biotechnology Patents?" United States Patents and Trademark Office.

V. Conclusions

In this paper, we examine patent pools, their efficiencies and potentially anticompetitive effects. General principles proposed in the *U.S. Guidelines* are reviewed and insights gathered from the economic literature on their implementation through two approaches, referred to as the Product and Litigation Rules. While it is well established that patent pools integrating complementary components are likely to be socially beneficial, they also have the potential to decrease incentives to innovate, discourage members from contesting weak patents and impact prices of competing goods. However, as economic research reveals, these effects are expected to be negligible or positive for complementary goods, especially when pools admit only valid patents and allow independent as well as bundled pricing.

In addition to complementarity, validity and independent pricing, *essentiality* has also been required for approval, defined as components that would necessarily be infringed if the standard is practiced (that is, they are technically required and without close substitutes). Indeed, antitrust concers regarding pools with nonessential patents[44] have an economic basis: Lerner and Tirole (2004) note that if the "competition margin" binds (i.e., the patents in the pool are sufficiently substitutable), a strategic private benefit exists from including nonessential patents in the pool when independent licensing is not allowed.[45] This does not apply to complementary pools, for which the inclusion of nonessential components is neither profitable nor problematic.

The latter result raises the question of whether the essentiality is too strict a litmus test for welfare-increasing pools. Gilbert (2009) believes it is, showing that over-inclusion is not likely to harm

[44]For example, in a letter to Carey R. Ramos (June 10, 1999), regarding the formation of pools for the DVD-Rom and DVD-video formats, the Assistant Attorney General stated: *"the inclusion in the pool of only one of the competing non-essential patents… could in certain cases unreasonably foreclose the non-included competing patents from use by manufacturers; because the manufacturers would obtain a license to the one patent with the pool, they might choose not to license any of the competing patents, even if they otherwise would regard the competitive patents as superior.*" However, as noted earlier, requiring essentiality for the purpose of limiting foreclosure is redundant if patentees are allowed to license independently.

[45]This strategy of bundling a nonessential input to a set of essential inputs is similar to the problem of strategic tying developed in Whinston (1990) and related literature.

competition as long as the pool includes at least one valid essential patent and patentees are free to license their components independently. This is particularly relevant in areas where standards do not apply or the final product does not yet exist, as in biotechnology and biomedical research, thus making the determination of what is and is not essential difficult at best (Gaulé (2006)).

Notwithstanding these important insights, the issue of essentiality requires further scrutiny. Nonessential patents imply that substitutes exist for the pooled patents and, therefore, the possibility for competing standards to emerge, unless blocked by incumbent pools. As the sewing machine case revealed, when patentees operate jointly, their incentives to foreclose competitors from the innovation market may increase. Whether pools alter incentives or facilitate litigation against outsiders capable of developing competing standards, remains an important question for future exploration given the increasing propensity of patentees to enter cooperative agreements.[46,47]

Since pools with substitutes are likely to be welfare decreasing, further complexities explored here for complementary pools would only strengthen the case against them. This observation reiterates the central importance of the relationship among products within (and outside) the pool. As noted earlier, these relationships are not always easy to determine and so it would be useful to identify observable indicators – alternatives to complementarity and substitutability – that distinguish between welfare-reducing and beneficial pools. For example, as shown by Lerner and Tirole (2004) and Lerner, Stojwas and Tirole (2007), grantbacks (the requirement to license intellectual property related to the pool) and independent licensing are two features that tend to be associated with pools of complements

[46] For example, the potential to restrict ongoing competition was a concern of the U.S. Justice Department in approving the multiple 3G platforms in which Qualcomm and other patentees have overlapping membership.

[47] Although they do not address this issue directly, the papers by Schiff and Aoki (2007) and Cabral and Salant (2008) on multiple standards provide useful frameworks for generating insights into this problem. In Schiff and Aoki, for example, two groups of firms, each supporting a standard (A and B), decide whether or not to pool their respective complementary patents. When the standards are non-compatible substitutes, the decision by one group (say A) to form a pool will not be profitable if the second group (B) decides to do the same thing. However, after B pools its patents, A and B may find it profitable to make their standards more compatible which will bring network benefits to consumers but may also soften competition. Given this framework, it is clear that A's incentives to threaten B with legal action will depend on expectations regarding B's *ex post* strategic decisions on pooling and compatibility.

but not substitutes. Hence, the absence of grantbacks or independent licensing in pool arrangements may be a screen for identifying suspect pools.   Finding other distinguishing (and observable) features of patent pools would help to sharpen the analysis and reduce the errors that admit anticompetitive pools or reject those that are socially beneficial.

Finally, the dynamic effects of a pool on innovation merit further attention. While several papers have examined the impact of patent pools on *ex ante* and *ex post* research activity, the focus typically has been on the *amount* of investment, rather than on the *composition* of the research.[48] In particular, it may be that in attempting to acquire valuable "bargaining chips" when patents are strong and the prospect of entering a patent pool is imminent, firms may sort themselves into complementary research paths by developing inventions that are valuable complements rather than duplicative substitutes. Anticipation of a future technology agreement may sort innovators into complementary paths that lead to a new standard (Fershtman and Kamien (1992)), but is may also direct the prospective pool members toward a standard that is a weaker substitute for the currently available one (Gallini (2011)). Relative to duplication of effort that might arise under weaker patents, this endogenous product response from stronger patents may offset some of the social costs incurred from an excessively protective IP system.

As noted in the Introduction, several authors have raised concerns regarding the effectiveness of the current patent system, with some even calling for its dissolution. However, recent research counters some of these negative charges. For example, Galasso and Schankerman (2010) provide empirical support for the hypothesis that the centralized Court of Appeals for the Federal Circuit may have facilitated technology diffusion by reducing uncertainty, settlement delays and the negative impact of fragmented negotiations. Furthermore, analysis of data from interviews with biotech and

[48]The direction of technical change is examined for the sewing machine pool in a companion paper by Lampe and Moser (2010b) to the one discussed above. The choice of technology is also explored in Eswaran and Gallini (1996) for firms choosing between product and process innovations and in Choi and Gerlach (2011).

pharmaceutical firms and universities, suggest that innovation in drugs has not been impeded by a patent thicket in research tools, although they caution that restricted access to essential upstream discoveries may warrant further scrutiny (Walsh, Arora, Cohen(2003), Walsh, Cho, Cohen (2005)).

As this debate continues to unfold, the impact of technology sharing agreements on prices, innovation and its diffusion should be more prominent in the benefit-cost calculus. Although the impact of patent pools on innovation remains inconclusive, they facilitate the technology transfer objective of a patent system.[49] Moreover, the review of patent pools in this paper reveals that private mechanisms have redeeming static efficiencies in lowering royalties on patented components, in promoting competition in downstream markets, and in reducing search and negotiation costs to users. Although private agreements are not expected to be an antidote for an ailing IP system, when constrained by the principles of competition policy they may play a significant role in countervailing at least some of the social costs generated by excessive protection.

[49] Several empirical studies provide persuasive support that stronger IP protection generally encourage technology transfer. See for example, Branstetter-Fisman-Foley (2006), Kanwar (2010) and the papers referenced in Gallini (2002).

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