Objective Identification of Patent Thickets:
A Network Analytic Approach

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I. Introduction

When organizations in technology industries attempt to advance their innovative activities, they almost always must be cognizant of the intellectual property rights of others. When further innovation is thwarted, however, the situation can be described as a patent thicket.

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Although the term "patent thicket" seems to have originated in litigation in the 1970s regarding Xerox's dominance of a portion of the photocopier industry,[1] economist Carl Shapiro re-introduced the term in academic discourse in 2000. Shapiro defines a patent thicket more broadly to encompass the intellectual property portfolios of several companies that form "a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology," and he points out that "with cumulative innovation and multiple blocking patents, … patent rights can have the perverse effect of stifling, not encouraging, innovation" (2000, pg. 120).

Despite all that has been written about patent thickets,[2] an objective methodology for verifying the existence of a patent thicket has never been developed. Throughout the last 150 years, however, organizations have stumbled into a number of patent thickets and have occasionally responded by constructing patent pools, which this paper defines as organizational structures where multiple firms collectively aggregate patent rights into a package for licensing, either among themselves or to any potential licensees irrespective of membership in the pool. Such collaboration among technologically competing firms, however, has often encountered difficulty from an antitrust standpoint, even if the formation of the pool is pro-competitive.

While the existence of a patent thicket is a necessary but insufficient condition for demonstrating that a given collection of patents is a pro-competitive solution to a particular patent thicket problem, the antitrust regime has never had an objective method of verifying the existence of a patent thicket in a given section of patent space. In response to the lack of such a methodology, this paper proposes a tool to facilitate objectively demonstrating the existence of patent thickets.

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[1] *SCM Corp. v. Xerox Corp.*, 645 F.2d 1195 (2d Cir. 1981); *In re Xerox Corp.*, 86 F.T.C. 364 (1975).

[2] Part II of this paper contains a review of that literature.

The importance of developing such a methodology is most evident when evaluating a patent pool as a possible solution to a given patent thicket. While the antitrust and intellectual property regimes were frequently in tension for most of the 20th century, with patent pooling often facing rather aggressive antitrust enforcement even in situations where the pool was pro-competitive, recent developments indicate that these two areas of law can be aligned so as to foster rather than stifle innovation. The 1995 *Guidelines for the Licensing of Intellectual Property* ("*IP Guidelines*"), jointly issued by the U.S. Department of Justice ("DOJ") and the Federal Trade Commission ("FTC"), formally acknowledged that collective ownership structures for intellectual assets, including patent pools, could potentially be pro-competitive solutions to the patent thicket problem.

While the *IP Guidelines* represent a welcome change in attitude by the antitrust enforcement regime, notably absent are any specific methodologies for examining a patent pool in the antitrust context. In addressing that deficiency, this paper discusses the two major questions that should be asked when examining a patent pool that is purportedly attempting to solve a patent thicket problem. The first question is "Does a given collection of patents constitute a thicket?" The second question is "What is the nature of the relationships between the patents in the thicket?" While some theoretical work has been done regarding the nature of patent relationships, the primary focus of this paper is on the question of patent thicket identification, as the lack of an objective methodology for verifying the existence of a thicket has historically been quite troublesome.

Recent history also demonstrates the problematic nature of the antitrust regime's inability to objectively verify the existence of a patent thicket. On June 26, 1997, the DOJ issued a Business Review letter indicating that a patent pool based on MPEG-2, a technology standard for

compactly representing digital video and audio signals for consumer distribution, was deemed not to be in violation of the antitrust laws of the United States. Less than a year later, however, on March 24, 1998, the FTC filed a complaint against a patent pool formed around photorefractive keratectomy ("PRK"), or laser eye surgery technology, and ultimately forced the pool to dissolve. One of the FTC litigators would later write that the pool in question might actually have been a pro-competitive solution to a patent thicket (Newberg 2000), but by the time his article was published, the damage was done.

If both the MPEG pool and the PRK pool were formed in response to the patent thicket problem, why did the antitrust regime destroy one pool and allow the other pool to live? In order to answer that question, it is necessary to examine the patent thicket phenomenon in depth. Part II of this paper reviews the literature and prior research on patent thickets and patent pools, and Part III further discusses the two major questions that should be asked when examining a patent pool that is purportedly attempting to solve a patent thicket problem. Part IV of this paper reviews the history of patent pool litigation to identify whether courts have ever examined those questions in the process of assessing the legality of patent pools in the shadow of the antitrust regime. Part IV also contains a discussion of two additional antitrust policy initiatives, the Nine No-No's of the 1970s and the *IP Guidelines* issued in 1995, and examines whether or not those initiatives addressed the issue of underlying patent thickets when analyzing patent pools. This review finds a general lack of focus on patent thicket questions in both the judicial and regulatory history

Given that the actual existence of a patent thicket is a necessary but insufficient condition for a pro-competitive combination of patents, this paper proposes a thicket identification methodology in Part V, using a network analytic technique to determine if a patent pool is

coincident with an underlying patent thicket. In order to validate the utility of the proposed methodology, Part VI presents case studies of the MPEG and PRK pools and then analyzes the pooled patents in those cases to see if they can be shown to be coincident with a patent thicket. Part VII reviews the findings from the case studies and the network analysis of the respective patent pools and highlights several lessons that can be drawn. Part VIII concludes the paper with a discussion of the contributions and limitations of the proposed methodology for patent thicket identification.

II. Background

A. The Problem of Patent Thickets

Patent thickets are not a new phenomenon, and when the total number of owners of the conflicting intellectual property rights is small, the response to the patent thicket problem has often been to cross-license (Grindley & Teece 1997; Teece 1998; Teece 2000). When more than two parties are involved, however, the transaction costs of cross-licensing between all of the parties can be prohibitive, and additional economic barriers exist such as hold-ups and double marginalization (Viscusi *et al.* 2000). In response to these challenges throughout the last 150 years, organizations have attempted to solve the multi-party patent thicketing problem by constructing patent pools. Usually, each firm assigns or licenses its individual intellectual property rights to a specific entity that in turn exploits the collective rights by licensing, manufacturing, or both. Different licensing arrangements are then available, depending on whether the licensee is a member of the pool and how the resulting royalties are subsequently distributed among the members of the pool.

While even the United States Patent and Trademark Office ("USPTO") has suggested patent pooling as a solution to the patent thicketing problem (Clark *et al.* 2000), the cooperative formation of patent pools by technologically competing firms has often encountered difficulty

from an antitrust standpoint, even if the pool itself has pro-competitive benefits. While few technological spaces have had more concern about patent thickets than biomedical research (Clark *et al.* 2000; Glover 2002; Heller & Eisenberg 1998; Horn 2003), despite the fact that the patent thickets in medicine and the life sciences are just as dense if not denser as those in standards-based industries such as telecommunications and consumer electronics, the treatment of the PRK pool seems to have had a chilling effect on subsequent pool formation outside of standards-based industries.

B. Prior Research on Patent Thickets and Patent Pools

The problem of patent thickets has recently caught the attention of much of the scientific and engineering community in a number of technological arenas (Clark *et al.* 2000; FTC 2002; FTC 2003; Glover 2002; Heller & Eisenberg 1998; Horn 2003; Lerner *et al.* 2003; Merges 1999; Newberg 2000). For example, firms in the semiconductor industry "find it all too easy to unintentionally infringe on a patent in designing a microprocessor, potentially exposing themselves to billions of dollars of liability and/or an injunction forcing them to cease production" (Shapiro 2000, p. 121). Heller and Eisenberg lament the "anticommons" in biomedical research due to the problem of patent thicketing (1998). Particularly in the biopharmaceutical industry, patent thickets threaten the process of cumulative innovation because they act "as barriers to entry [that prevent new entrants] from using the technologies protected by such patent thickets" (Glover 2002, p. C10).

A recent FTC report notes that in certain industries the large number of issued patents makes it virtually impossible to search all the potentially relevant patents, review the claims contained in each of those patents, and evaluate the infringement risk or the need for a license (2003). For the software industry the report cites testimony about the hold-up problems and

points out "that the owner of any one of the multitude of patented technologies constituting a software program can hold up production of innovative new software" (2003, ch2, p. 3). For many firms, the only practical response to this problem of unintentional and sometimes unavoidable patent infringement is to file hundreds of patents each year so as to have something to trade during cross-licensing negotiations. In other words, the only rational response to the large number of patents in a given field may be to contribute to it.

Patent pools are perhaps an alternative response, but although the revenues generated from sales of devices based in whole or in part on patent pool technologies are at least $100 billion US per year (Clarkson 2003), the patent pooling phenomenon has received few scholarly treatments, and most of those have been historical in nature. Vaughan (1925) describes patent pool formation in the late 19th and early 20th century and examines a number of early pools. Three examinations of the phenomenon have been in the form of case studies. Cassady (1959) examines the formation and operation of a patent pool by Thomas Edison that aggregated all of the important patents for the early motion picture industry. Thompson (1987) describes the first patent pool, which was formed in the 19th century around intellectual property conflicts in the sewing machine industry. Bittlingmayer (1988) examines the formation of an aircraft patent pool during World War I. While many scholars have written favorably about patent pool formation (Merges 1996; Merges 1999; Newberg 2000; Vaughan 1925), others have focused on potential competitive problems posed by patent pools (Carlson 1999; Priest 1977; Taylor 1992).

A number of economists have recently written on patent pools. Both Choi (2003) and Shapiro (2003) have examined patent pools in the context of patent litigation settlements constrained by antitrust law. In a different article specifically examining patent pools, Shapiro (2000) uses Cournot's original analysis of the "complements problem" (Cournot 1838) to argue

that patent pools raise welfare when patents are perfect complements and harm welfare when they are perfect substitutes. Work by Lerner and Tirole (2002) extends the analysis by examining the strategic incentives to form a pool in the presence of current and future innovations that are either substitutes for or complements to the patents in the pool. Their model allows examination of the full range between the polar cases of perfectly substitutable and perfectly complementary patents. Their paper concludes that while much research is yet to be done, the construction of pro-competitive pools is certainly possible. Stable pools can be formed by clearly defining patent essentialness and by scrutinizing the economic incentives provided to patent holders through pool membership versus independent licensing.

Their second paper on patent pools empirically examines the positive aspects of these arrangements, developing a set of theoretical predictions concerning the pool structure (Lerner *et al.* 2003). They predict how the attributes of the pool vary with their key characteristics, such as the number of members of the pool and the rate of technical advance in the industry. They sample 63 pools established between 1895 and 2001 from the dockets of court cases, the archives of congressional hearings, and many other sources, to determine the actual structure of the pooling agreements. Their study concludes that the dynamics of management become more centralized as the pool grows larger. As pool membership increases, third-party licensing becomes more common. Such a finding is significant because restrictions on third-party licensing have historically been a trigger for antitrust scrutiny.

Gilbert (2002) reviews the antitrust treatment of patent pooling over the same time period and examines the factors that the courts identified as pertinent to the antitrust outcome. He concludes that until recently, the competitive relationship of the patents was not a major

determinant of the antitrust outcome in most cases. Instead, he suggests that the courts have focused on restrictive licensing terms that affect downstream prices.

III. Patent Thicket Questions

In any analysis of a proposed solution to a purported patent thicket problem, two primary questions must be addressed. The first question is "Does a given collection of patents constitute a thicket?" The answer to this question is critical because the actual existence of a patent thicket is a necessary but insufficient condition for a pro-competitive combination. The second question is "What is the nature of the relationships between the patents in the thicket?" The standard taxonomy categorizes the economic relationship between individual patents as blocking, complementary, independent, or substitute (Andewelt 1984; Newberg 2000), or "BCIS." The elimination of substitutes is also a necessary but insufficient condition for a pro-competitive pooling solution to a patent thicket.

Although there is a clear temptation to immediately address the BCIS categorizations, without first developing a methodology for objectively identifying the existence of thickets, any attempts to segment thickets into BCIS categories would likely be problematic. Thus, although the next two sections will discuss both questions, this paper will only demonstrate a methodology for answering the first question. Answering the question of thicket existence, however, is a first step toward empirical usefulness of the theoretical BCIS framework.

A. Existence of a Patent Thicket

Although most of the recent analyses of patent pools have been economic, the economists have not provided a method for objectively determining the existence of a patent thicket. The nature of patents suggests, however, that a network analytic approach might prove instructive in identifying patent thickets. Social Network Analysis is a methodology developed by sociologists

and organizational theorists to examine the social structure of groups. In this type of analysis, individuals are identified as the actors in a network, and the relationships between those actors are identified as ties. If the relationship from actor A to actor B can be different than that from actor B to actor A, the network is referred to as a directed network (or directed graph).

While social network analysis, as a science, has been most commonly applied to describe complex dynamics in human interaction, the underlying theory and methodology is not limited to interpersonal relationships. Network analysis describes the relationships among nodes, be they people, computers, power stations, or academic papers, as some form of resources that moves from one node to another. Network analysis has been applied to describe numerous human interaction webs – opinions and rumors (Watts 1999), diseases and epidemics (Newman 2002), and even terrorist cells (Carley et al. 2003; Krebs 2002). The dynamics of resources moving from one location to another is not specifically the province of human interaction. Network analysis has also been applied to uncover the nature of non-human phenomena, such as the power blackout in the eastern United States during the summer of 2003 or the spread of computer viruses (Newman et al. 2002).

Existing network analytic research in other areas of information sciences has concentrated on patterns of citation in literature and research (Price 1965; Price 1976; Redner 1998). Physicist Mark Newman has written extensively on the analysis of citation networks within academic communities and scholarly publishing (2000; 2001). Patents share many similar characteristics – citation practices in particular – to academic works, and that research is quite relevant. Patent space as an information network bears significant similarity to academic citation networks on the basis of temporal limitations that specifically affect the directionality of linking vectors within a network. Similar to academic papers, a new entrant can only give citation to

previous research, or "prior art." Because of this linear path, patents that give rise to increased innovation can be seen as significant in creating lineages or families of technologies – possibly the seeds from which a patent thicket grows (Freeman 1979).[3]

Previous work has demonstrated the methodological validity of using network analysis on patents. In an early study of patent networks, Podolny and Stuart (1995) developed the concept of a "technological niche" that included a focal innovation, the innovations on which the focal innovations built, the innovations that built upon the focal innovation, and the technological ties among the innovations within the niche. Using patents as the network nodes and patent citations as the network ties between nodes, they then were able to measure characteristics of innovation niches within the semiconductor industry to determine how subsequent innovations may or may not build upon the focal innovation. Those same authors used similar techniques in two subsequent articles. One article examined the evolution of technological positions among firms (Stuart & Podolny 1996), and the other examined organizational survival within technological niches (Podolny et al. 1996).

Not only did these early studies establish the methodological validity of applying network analytic techniques to patent networks in general but also much of their analysis of technological niches and competitive crowding was based on a variation of network density, a fundamental network analytic concept (Marsden 1990; Wasserman & Faust 1994). To facilitate the identification of patent thickets within a larger patent space, this paper presents a new measure of patent thicket density in Part V.

[3] As an example, the ISI Web of Knowledge (a scholarly citation database) indicates that Shapiro's patent thicket article has been cited at least 21 times in social science journals (4 times as a working paper and 17 times as the published article). Additionally, a quick Westlaw search reveals that the article has also been cited by at least 30 legal journals.

B. Composition of a Patent Thicket

In order to further analyze a patent thicket to determine which combinations of patents might be pro-competitive, a classification scheme that describes the different ways that patents can relate to each other is needed. The BCIS categorization scheme identifies those relationships as follows.

1. Blocking

When Patent A blocks Patent B, the owner of patent B cannot practice the invention without a license from the owner of patent A. For example, an improvement on a patented machine (improved Patent B) can be blocked by the original Patent A on the machine. The owner of patent A, however, cannot practice the particular improved feature claimed in patent B without a license from B's owner. Sometimes the blocking can be discerned from the patent citations, but at other times the blocking would only be evident from an evaluation of the text of the respective patents themselves (indicated by the dashed lines in Figure 1).[4]

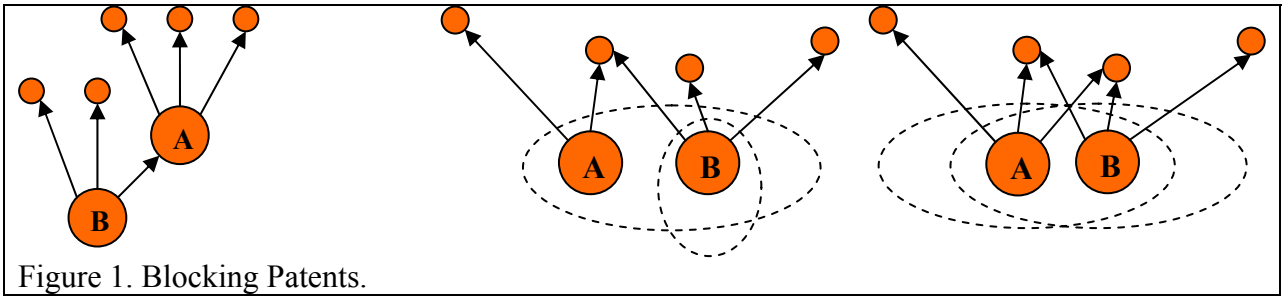

Figure 1. Blocking Patents.

Newberg notes that the "connection between blocking relationships and innovation bears emphasis because what is paradigmatically 'blocked' in a 'blocking' relationship among patents is the practice of an innovative, patented improvement upon an existing patented invention" (Newberg 2000, p. 4). Merges & Nelson identify the blocking problem as one of patent scope.

[4] This nuanced notion of the scope of a patent defined by the dashed lines is referred to as the doctrine of equivalents. This doctrine is quite complicated, often litigated, and beyond the scope of this paper.

> Two patents are said to block each other when one patentee has a broad patent on an invention and another has a narrower patent on some improved feature of that invention. The broad patent is said to "dominate" the narrower one. In such a situation, the holder of the narrower ("subservient") patent cannot practice the invention without a license from the holder of the dominant patent. At the same time, the holder of the dominant patent cannot practice the particular improved feature claimed in the narrower patent without a license. (Merges & Nelson 1990, pp. 860-861)

2. Complementary

Two patents that provide an additional benefit when used in combination are complements. A catalyzing technology would be considered complementary to the technology that is enhanced by its inclusion. Unlike blocking patents, however, complementary patents can each be practiced independently without requiring a license for the other patent.

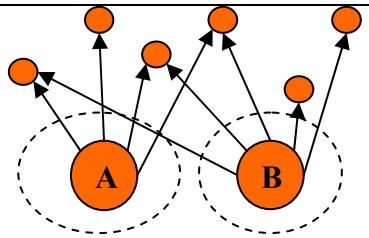

Figure 2. Complementary Patents.

Combining complementary patents establishes a vertical relationship (USDOJ/FTC 1995) and provides many of the benefits of vertical integration, including the reduction of transaction costs and the elimination of double marginalization (Viscusi *et al.* 2000).

3. Independent

Two patents that do different things and have a different intellectual heritage are independent.

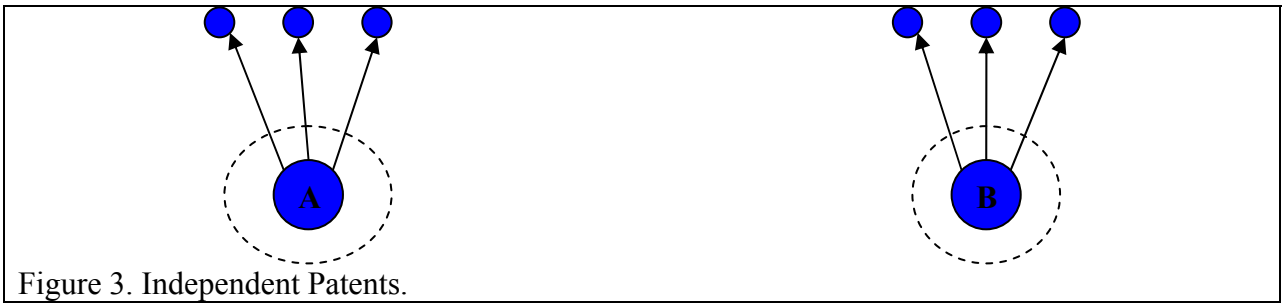

Figure 3. Independent Patents.

4. Substitute

Two patents that perform substantially identical functions or fulfill the same role but can be practiced independently are considered substitutes. By definition, a pool cannot be pro-competitive if it includes substitutes, as such a situation will reduce competition both in the consumer markets as well as potentially in innovation markets.

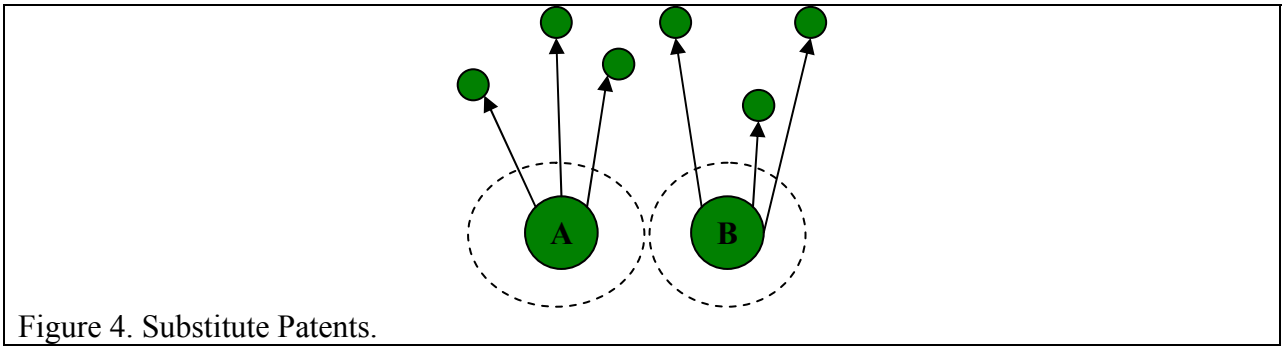

Figure 4. Substitute Patents.

C. Categorization Challenges and Limitations

The analysis of the relative competitive benefit or harm from a given combination of patents would of course be much easier if all of the potential relationships between patents neatly fell into one these four categories, but such is rarely the case. As Newberg notes,

> intellectual property often defies orderly categorization. The relationships among patents may, for example, have both complementary and horizontal aspects. Alternatively, the relationship among some patents may be best described as fundamentally uncertain or indeterminate. (2000, pp. 5-6)

Similarly, while the standard economic theory definition of substitutability suggests that two items are substitutes if increasing the price of one increases the demand for the other, Lerner and

Tirole argue that two patents may be complements at low prices but substitutes at high prices (2002).

While the difficulty of categorizing patent interrelationships is apparent, the determination of the actual existence of a patent thicket is a threshold question that needs to be answered first before proceeding with any attempt at categorization. Whether the history of patent pool litigation includes judicial determinations of the existence or non-existence of a patent thicket is examined in the next section.

IV. Historical Examination

According to Newberg, the FTC litigation involving the PRK patent pool either ignored or failed to detect the underlying laser eye surgery patent thicket (2000). Was such a failure a unique occurrence, or had it happened before? Was the failure due to a lack of analytical tools or frameworks, and if so, had prior litigation ever attempted to determine the existence of a patent thicket? When it occurred, did the examination of patent thicket questions have any impact of the fate of a given patent pool? These questions could only be answered by examining the history of patent pool litigation.

An exhaustive search of several electronic and hard copy sources yielded 124 cases of alleged patent pools accused of antitrust violations by either the Antitrust Division of the DOJ, the FTC, or private antitrust actions.[5] At times a given pool was the subject of multiple litigation proceedings, while at other times unfavorable decisions were appealed and the appellate

[5] The search began with the Lexis databases GENFED and Mergers and Acquisitions (M&A) Cases – Federal. The GENFED search resulted in 361 hits and the M&A search resulted in 126 hits (all of these turned out to be repeats of the GENFED results). The searches were then repeated in the Westlaw databases ALLCASES and ALLCASES-OLD. The ALLCASES search resulted in 282 hits and the ALLCASES-OLD search resulted in 45 hits.

The next step was to inspect the results and remove cases where patent pooling was not a major theme (in some instances, the courts cited a case involving patent pooling for reasons unrelated to the pool itself). The resultant set of cases was compared to the "Pooling and Interchange" section of the CCH Trade Regulation Reports, and a few cases were added that were not previously identified in the Westlaw/Lexis searches.

proceeding was then separately identified in the search for cases. Thus a total of 101 cases between 1900 and 1970 were analyzed.[6]

A. Patent Pool Litigation – 1900-1970

Although the set of patent pools identified is limited to those that were litigated, it is sufficient to provide a degree of insight into the evolution of antitrust enforcement and the criteria used to evaluate such pools. In examining the cases, I specifically looked for instances where the courts explored questions related to patent thickets.

In reviewing the 101 cases during this time period, the litigation appears to be categorizable along five primary dimensions:

1. Examination of patent thicket questions
2. Government enforcement activity vs. private antitrust litigation
3. Pre- or post- WWII decisions
4. Market issues[7]
5. Contractual issues[8]

Given that the main focus of the review of patent pool litigation was the examination of the first category, only the analysis relevant to judicial examination of patent thicket questions is presented here. In terms of that analysis, it appears that judges examined patent thicket questions more often in the early litigation than they did in more recent litigation. Of the twenty-two cases litigated prior to 1939, at least ten specifically addressed the issue of the existence of patent

[6] While an organizational structure where multiple firms collectively aggregate patent rights existed in most of the identified cases, it should also be noted that to be included in the list, a case merely had to raise the issue of patent pooling. The distinction between certain cross-licensing regimes and a formal patent pool was not readily discernable in some cases. A comparison of the actual agreements, such as those identified by Lerner *et al.* (2003), would certainly facilitate a further refinement of this list of cases, as it is possible for one party to raise allegations regarding the operation of a pool without a patent pool actually existing.

[7] Including the level of industry dominance and the presence or absence of foreign corporations (particularly German corporations) in the pool.

[8] Contractual issues included patent pool via assignment, cross-licenses, mergers/acquisition, or patent holding entity; patent pool as the primary scheme or element of larger collusive scheme; presence or absence of tying provisions; provisions for territorial allocations, agreement not to challenge other patents in the pool, provisions covering future patents acquired or successfully innovated, litigation coordinated for purposes of intimidation via infringement suits.

thickets. While a few of those analyses may have been questionable, the courts were at least attempting to examine the issue. In contrast, from 1939 to 1949, forty-three pools were litigated, but patent thicket questions were only considered five times.[9] The likelihood of thicket examination was even slightly lower during the next three decades. Of the thirty-nine additional patent pools litigated between 1940 and 1969, patent thicket questions appear to have been examined only four times.

Although patent thicket questions were infrequently examined, it appears that their examination was potentially quite important for pool survival. In terms of overall litigation outcomes between 1900 and 1970, 21% of the identified patent pools survived litigation.[10] When patent thicket questions were addressed, however, 59% of those pools survived. When the data are cross-tabulated, a Chi-Square test indicates an association between pool survival and the examination of thicket questions.[11]

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[9] A lack of a sufficient factual record may explain a two instances of non-examination of thicket questions during this period, such as in *U.S. v. Wayne Pump Co.*, 317 U.S. 200 (1942), where the Supreme Court criticized the government for not even introducing any evidence that the patents might have been substitutes. On the other hand, in *U.S. v. General Electric*, 80 F.Supp. 989 (S.D.N.Y 1948), the district found the conduct so egregious that it decided that the patent thicket questions were not germane. In thirty-six of the forty-three cases, however, the patent thicket questions do not appear to have been examined at all.

[10] The survival assessment was based on the outcome of the highest level proceeding, since in certain instances an appellate court reviewed the findings of a lower court.

[11] In their examination of the actual pooling agreements, Lerner *et al*. (2003) develop an analytic model of contract structure that bifurcates their sample into pools formed before and after the *Hartford-Empire v. U.S.* decision, 323 U.S. 386 (1945). Bifurcation at this point also divides the sample into pre- and post- WWII decisions, as *Hartford-Empire* was the last patent pool case decided before the end of WWII. Justice Black wrote in that case that the "history of this country has perhaps never witnessed a more completely successful economic tyranny over any field of industry than that accomplished by [the pool members]" 323 US 436-437. The remedy imposed matched the harshness of the rhetoric. The Court upheld the district court's order requiring that a receiver be appointed for the lead company free from any claim to a stay, that royalties received pending final resolution be set aside for return to licensees, and that all its patents be made available royalty free to any interested party. The Court also cancelled all current agreements, leases, and licenses required. The remedy was truly a nuclear bomb in terms of antitrust enforcement.

Hartford-Empire appears to have been a watershed event in terms of antitrust enforcement against patent pools. In terms of the impact of that decision on the association between pool survival and the examination of thicket questions, however, bifurcating the sample does not appear to change the result for either cases up through *Hartford-Empire* (Fisher's Exact $p = 0.004$) or cases after *Hartford-Empire* (Fisher's Exact $p = 0.035$). A Fisher's Exact was used in these cases instead of a Chi-Square test because certain cell counts were less than 5.

Pool survived	Thicket questions examined? No	Yes	Total
No	71	9	80
Yes	8	13	21
Total	79	22	101

Pearson $\chi 2$ = 25.0508 Pr = 0.000

Table 1. Test for an association between pool survival and the examination of patent thicket questions in patent pool litigation between 1900 and 1970.

Given the association between pool survival and the examination of thicket questions, a logical question to pose is whether or not the availability of an objective methodology for determining the existence of a patent thicket would have made any difference in the historical cases. If the reluctance of the courts to examine the patent thicket questions was due in part to the lack of a methodology for identifying the existence of thickets, then clearly the availability of such a methodology would have increased the percentage of cases in which thicket questions were posed. The data indicate an association between pool survival and the examination of thicket questions by the courts, so it is certainly possible that with a methodology for determining the existence of patent thickets, more pools might have survived. One case in particular, *U.S. v. Line Material Co.*,[12] certainly had a dense thicket that seems to have been ignored by the court. If that case had come out in favor of the pool, the dismal record of patent pool survival after WWII might have been fundamentally different, as *Line Material* was often cited as precedent in subsequent patent pool litigation.[13]

Based on the range of issues considered by the courts in the identified patent pool cases, however, building a model to actually predict litigation outcomes is clearly fraught with

[12] 333 U.S. 287 (1948)

[13] Ultimately the *IP Guidelines* implicitly, but quite unmistakably, reject the holding in *Line Material*. *See IP Guidelines* §§ 3.4 & 5.5.

difficulty. In his analysis of twenty patent pooling decisions, Gilbert proposes to categorize pools along three dimensions

- The existence of a patent thicket
- The presence of vertical restrictions in licensing terms that affect competition related to the patented products or processes
- The existence of agreements not to license the patents and to cooperate in the defense of the patents

and then develops a scoring mechanism to assess the relative levels of anti-competitiveness of the pools (2002). Gilbert laments that while he would have preferred to see high scores for combinations that were found to have violated the antitrust laws and low scores for those that did not, such a pattern did not emerge until the 1970s.

A valid explanation for the pattern of patent pool decisions could be that while judges may have been able to assess the competitive implications of specific contractual provisions in a patent pooling agreement, they were ill-equipped to evaluate questions related to patent thickets. Whatever the reason for the judicial reluctance to delve into patent thicket questions, the judicial focus on contract structure and market dynamics was subsequently incorporated into a formalized regulatory framework.

B. The Era of the Nine No-No's – 1970-1995

Having amassed an impressive set of victories in patent pool enforcement cases, in 1970 the Antitrust Division of the DOJ articulated what came to be known as the "Nine No-No's," essentially a watchlist of nine specified licensing practices[14] that the division viewed as

[14] These licensing practices were described in at least one speech by then Deputy Assistant Attorney General Bruce B. Wilson as practices "which in virtually all cases are going to lead to antitrust trouble because of their adverse effect upon competition" (Wilson 1970, p. 9). The prohibited licensing practices consisted of the following:

1. Requiring the licensee to purchase unpatented supplies (tie-ins);
2. Requiring the licensee to assign to the patentee patents that may be issued to the licensee after the licensing arrangement is executed (mandatory grantbacks);
3. Imposing post-sale restrictions on resale by purchasers of patented products;
4. Restraining licensees' commerce outside the scope of the patent (tie-outs);
5. Giving licensees veto power over grants of further licenses;

anticompetitive and that would attract the scrutiny of the DOJ (Gilbert & Shapiro 1997; Tom & Newberg 1997). Conspicuously absent from the Nine No-No's, however, was any consideration of patent thicket questions.

The attitude of the antitrust enforcement regime thus remained quite hostile towards patent licensing (Carlson 1999), and the contractual focus of both the DOJ and the FTC resulted in a presumption of market power to the patent grant without any consideration of the structural characteristics of the marketplace in which the patented products competed (USDOJ/FTC 1995), and little weight was afforded to efficiency considerations of any licensing restrictions.

Although the trend started in the 1960s, after the Nine No-No's were issued, the number of pooling cases that were litigated dwindled significantly, and few of the opinions addressed the legality of the pools themselves. As Merges notes,

> federal antitrust policy is the most likely explanation for the small number of patent pools existing today. Ever since myriad forms of inter-firm cooperation were condemned in the "trust-busting era," firms have been reluctant to initiate industry-wide arrangements of every ilk, including pools. … [T]he relative scarcity of pools on the present landscape—especially given the increasing presence and strength of patents in many industries—suggests a classic case of excessive deterrence. (1996, p. 1351-1352)

While the patent pooling case law could thus be appropriately classified as muddled and often hostile to potentially pro-competitive patent pools, a possible regulatory solution was forming over the horizon that would provide a degree of clarity.

C. The Introduction of the IP Guidelines

As technology progressed in the 1980s, intellectual property rights became more and more important. As patent thickets became denser, the level of economic thought that could be

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6. Mandating package licensing;
7. Requiring payment of royalties in amounts not reasonably related to sales of the patented product;
8. Restraining sales of unpatented products made by a patented process;
9. Specifying prices licensee could charge upon resale of licensed products.

applied to antitrust analysis in the intellectual property arena continued to increase in sophistication. Beginning in the early 1980s, the Antitrust Division of the DOJ began to question the theoretical foundation of the Nine No-No's (Gilbert & Shapiro 1997), in part because of the emerging notion that unconstrained patent licensing might actually increase the value of patents and encourage subsequent licensing and innovation.

The first attempt at revising the official position of the antitrust enforcement regime came in 1988 with the release of the *Antitrust Enforcement Guidelines for International Operations* ("*1988 Guidelines*"). Included in the *1988 Guidelines* was a repudiation of the notion that a patent, copyright, or trade secret automatically created a "monopoly" for its owner, and therefore should be subject to close antitrust scrutiny. Instead the *1988 Guidelines* established a core principal that the owner of intellectual property is entitled to whatever market power exclusive ownership of the property itself confers. Additionally, the *1988 Guidelines* incorporated a concept that recognized that intellectual property licensing allows firms to combine complementary factors of production and is generally a pro-competitive response to the problem posed by patent thickets. The *1988 Guidelines* also provided that intellectual property licenses where the licensor and licensee did not directly compete in the market affected by the license would almost never be challenged. In the case of a horizontal arrangement, where the licensor and licensee did compete in the market for the licensed product, the *1988 Guidelines* called for an analysis of the license under the "rule-of-reason" that allowed for the balancing of the pro-competitive benefits of the license against any potential anticompetitive effects, if there were any. Although the *1988 Guidelines* included certain provisions that could be helpful in clearing patent thickets, the focus was still on contractual and marketplace issues and no specific methodology was proposed to identify the existence of patent thickets.

Seven years later, on April 6, 1995, the DOJ and the FTC jointly released the *IP Guidelines*, which superseded certain portions of the *1988 Guidelines* as they pertained to intellectual property. Several core principles were retained, however, including

- An endorsement of the validity of treating intellectual property as essentially comparable to tangible or intangible property for the purposes of antitrust analysis;
- An acknowledgement that intellectual property does not necessarily create market power in the antitrust context; and
- An explicit recognition of the generally pro-competitive nature of licensing arrangements.

The *IP Guidelines* specifically mention patent pools, noting that such arrangements may provide pro-competitive benefits by "integrating complementary technologies, reducing transaction costs, clearing blocking positions, and avoiding costly infringement litigation. By promoting the dissemination of technology, … pooling arrangements are often pro-competitive" (USDOJ/FTC 1995, §5.5).

While the *IP Guidelines* describe the likely response to various outcomes of a BCIS-type inquiry,[15] they provide no indication of how such an inquiry would be conducted. Similarly, while acknowledging the importance of solving patent thicket problems, the *IP Guidelines* failed to include an objective methodology for assessing the existence of a patent thicket. The next section proposes just such a thicket identification methodology.

V. Objective Thicket Identification

As more and more patents issue, patent thickets become both denser and more numerous. Given that patent pools may be the only viable solution in certain instances, an objective methodology for demonstrating the existence of an underlying patent thicket would allow

[15] Under the *IP Guidelines* patent pools that aggregate substitute patents are immediately suspect while patent pools that aggregate complementary or blocking patents are unlikely to be challenged absent "collateral restraints that would likely raise price or reduce output in the relevant goods market or in any other relevant antitrust market and that are not reasonably related to an efficiency-enhancing integration of economic activity" (USDOJ/FTC 1995, §5.5 Ex 10).

organizations attempting to form a patent pool to satisfy a necessary condition for the pool to be pro-competitive. For guidance on developing such a methodology, Shapiro provides a theoretical basis for establishing the existence of a patent thicket coincident with a patent pool.

Given that Shapiro defines a patent thicket as "a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology" (2000, pg. 120), measuring density is a logical direction of inquiry. Building upon his premise that a patent pool is a natural market-clearing mechanism that forms within a patent thicket, it should be possible to verify that the density of patents within known pools is higher than the surrounding patent space. If the density measures of established pools are significantly higher than the density of their surrounding patent space, that finding will contribute a new dimension to the definition of patent thickets. Clearly, the number of existing patent pools is potentially less than the number of patent thickets; however, establishing objective criteria to identify thickets may have economic and policy implications in clearing innovation markets that may be stagnating under impassable negotiation and competition barriers. For the purposes of this paper, however, the examination is limited to the determination of whether or not the given pools are coincident with patent thickets.

A. Exploring Patent Networks

To evaluate this threshold question of the existence or non-existence of a patent thicket, I propose a measure of patent thicket density. The standard network density equation (Wasserman & Faust 1994) for a directed network with g nodes

$$\Delta = \frac{\sum_{i=1}^{g}\sum_{j=1}^{g} x_{ij}}{g(g-1)} \qquad (1)$$

essentially counts up the total number of ties in a network and divides that total by the number of possible ties, where x_{ij} is the value of the tie from node *i* to node *j*. A core assumption of the standard density calculation is that each node in the network has a possible tie to each of the other nodes, an assumption which does not hold true for patents. In order to derive a density calculation for patent networks, it is necessary to deconstruct the standard calculation and then rebuild a patent-capable density calculation.

For a *g*-node network, each node *n* can cite *g*-1 other nodes. Thus the total possible number of nodes is *g*(*g*-1), which is the denominator in the standard calculation. Individually, each node *n* has a local network density Δ_n, which equals the number of ties to and from node *n* divided by the total possible ties for that node, *g*-1.

$$\Delta_n = \sum_{j=1}^{g} \frac{x_{nj}}{g-1} \qquad (2)$$

Summing the local densities for all *g* nodes and dividing by *g* results in the standard density equation (1) above. Note that each local density has the same denominator *g*-1, which is only true if each node *n* can tie to each of the *g*-1 other nodes in the network.

That assumption does not hold true for patents, as any given patent can only cite patents that were issued previously. Subsequent patents cannot be cited by a prior patent, and thus the standard density equation cannot accurately correspond to patent network density.

B. Deriving Patent Network Density

Assuming a patent network with *g* patents, each node *n* can cite *n*-1 other patents.[16] As one traverses the patent network chronologically, younger patents have more and more possible citations that they can make. The oldest patent in the network, however, will have zero possible

[16] The network analytic term for citations made to other patents is "outdegrees." Citations received from other patents are called "indegrees."

citations to make,[17] which would result in an undefined local density for that patent. The local density for the oldest patent is thus discarded to avoid an undefined result.[18] Local patent density Δ_{np} for each subsequent patent n is derived by totaling up the citations actually made, or outdegrees, and dividing by the possible citations that could be made by that patent.

$$\Delta_{np} = \sum_{j=1}^{g} \frac{x_{nj}}{n-1} \qquad (3)$$

The average density for a patent network based on citations made is then derived by summing the remaining patent densities and dividing by g-1. Thus patent network density $\Delta_{p\text{-}out}$ is

$$\Delta_{p-out} = \frac{\sum_{n=2}^{g} \sum_{j=1}^{g} \frac{x_{nj}}{n-1}}{g-1} \qquad (4)$$

While Formula (4) is a density measure based on citations made, or outdegrees, it may be useful in certain circumstances to calculate patent network density using citations received, or indegrees.[19] Rewriting Formula (4) to use citations received requires a few modifications. Instead of discarding the local density of the oldest patent, the local indegree density for the youngest patent is discarded, as no other patents in the network can cite to it.

[17] Citations to patents outside the network are discarded for the purposes of density calculations, as those prior patents do not constitute nodes in the network.

[18] There is a secondary reason to discard the local density for the oldest patent that is related to the calculation of standard deviation. In a complete network, where all possible ties are in fact actual ties, average density is one and standard deviation is zero. Formula (4) yields an average patent density of one when the oldest patent is excluded (along with its undefined local density). The standard deviation of the local patent densities is also zero once the oldest patent is excluded.

[19] Citations received might be an indication of importance or knowledge flows (Jaffe & Trajtenberg 1999; Jaffe & Trajtenberg 2002; Jaffe *et al.* 1993), although the nature of patent citations casts significant doubt as to whether patent citations can be used as a direct proxy for knowledge transfer.

$$\Delta_{p-in} = \frac{\sum_{j=1}^{g}\sum_{n=2}^{g}\frac{x_{jn}}{n-1}}{g-1} \qquad (5)$$

C. Applying Patent Network Density

After deriving a measure for patent network density, the next step is to apply it to a network and compare the results to the standard density calculation. Assume a six patent network as shown in Figure 1.

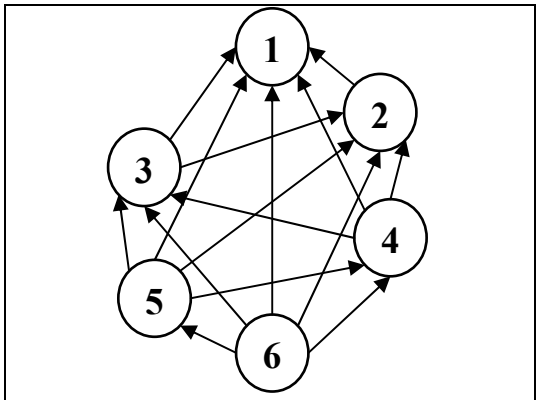

Figure 1. Patent Network A

If all possible citations are in fact actual citations, the resulting patent network is complete, which should result in an average density of one and a standard deviation of zero (Wasserman & Faust 1994). Formula (4) returns the appropriate result, as shown in Table 2. The indegree variant, Formula (5), also returns the appropriate result, as shown in Table 3.

Patent	Outdegree Citations	Possible Outdegree	Local Density	Patent	Indegree Citations	Possible Indegree	Local Density

		Citations	
1			
2	1	1	1.00
3	2	2	1.00
4	3	3	1.00
5	4	4	1.00
6	5	5	1.00
Average Density			1.00
Standard Deviation			0.00

Table 2. Patent Network Density for Network A (Citations Made/Outdegree).

		Citations	
1	5	5	1.00
2	4	4	1.00
3	3	3	1.00
4	2	2	1.00
5	1	1	1.00
6			1.00
Average Density			1.00
Standard Deviation			0.00

Table 3. Patent Network Density for Network A (Citations Received/Indegree).

Formula (1), the standard network density calculation, produces an entirely different result for Network A. Although Network A is a complete network from a patent citation standpoint, Formula (1) returns a density of 0.5.

Having established that "complete" networks are calculated appropriately using both measures of density, the next task is to examine networks that are less than complete. Assume a different six-patent network as shown in Figure 2, where the oldest patent is cited by each of the other patents, but no other citations are present in the patent network.

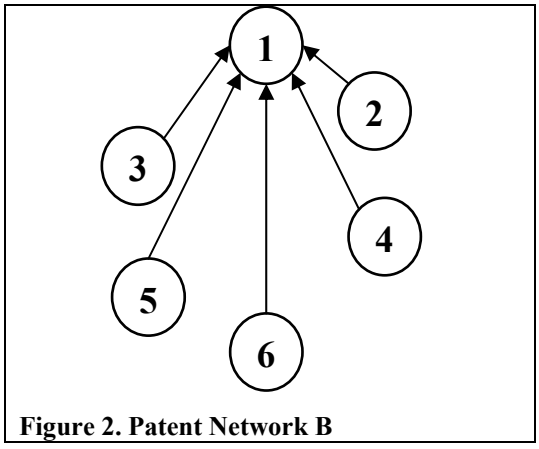

Figure 2. Patent Network B

In this scenario, the results returned by Formulas (4) and (5) are not the same.

Patent	Outdegree Citations	Possible Outdegree Citations	Local Density
1			
2	1	1	1.00
3	1	2	0.50
4	1	3	0.33
5	1	4	0.25
6	1	5	0.20
Average Density			0.46
Standard Deviation			0.32

Table 4. Patent Network Density for Network B (Citations Made/Outdegree).

Patent	Indegree Citations	Possible Indegree Citations	Local Density
1	5	5	1.00
2	0	4	0.00
3	0	3	0.00
4	0	2	0.00
5	0	1	0.00
6			
Average Density			0.20
Standard Deviation			0.45

Table 5. Patent Network Density for Network B (Citations Received/Indegree).

Both formulas, however, return higher average densities than Formula (1), which returns an average density of 0.1667.

Intra-network citations made by earlier patents are given more weight in Formula (4) because the denominator for each local density is the number of possible citations that can be made. Formula (5) behaves similarly, although citations made to more recent patents are given more weight. While treating such earlier or later citations as more important might seem appropriate for analyzing patent thickets and patent pools, a weighted density measure would likely be somewhat more robust.

Weighting each local density by the possible number of citations results in a weighted average patent network density Δ_p.

$$\Delta_p = \frac{\sum_{n=1}^{g}\sum_{j=1}^{g} x_{nj}}{g(g-1)/2} \qquad (6)$$

This formulation of patent network density has a number of advantages. Formula (6) still produces the proper result for a complete network and is simpler to calculate than either Formula (4) or (5). Additionally, as with Formula (1), calculating density based on citations made results

in the same density for citations received.[20] Whereas the result of Formulas (4) and (5) will vary depending on which individual patents cite other patents like Formula (1), Formula (6) is not affected by variations in citation placement so long as the total number of citations remains the same.

D. Identifying the Existence of a Patent Thicket

In order to validate the measure of patent network density Δ_p, it would be useful to examine an area of the intellectual property space that is likely to have variation in densities. As discussed earlier, a logical starting point is Shapiro's suggestion that patent pools form where patent thickets already exist. If a patent pool is coincident with a patent thicket, then the density of the pool should be higher than the surrounding patent universe. As an alternative to calculating the density for the complete universe of patents in a given set of technology classes, a relevant near universe may be able to be constructed which should still provide a sufficient density contrast to identify a patent thicket. Although there has been relatively little empirical examination of network density (Marsden 1990; Wasserman & Faust 1994), both of these propositions can be stated as testable hypotheses:

H1: Patent network density Δ_p will be higher for a patent thicket than for the surrounding patent universe.

H2: Patent network density Δ_p will be higher for a patent thicket than for a relevant near universe.

This exercise is analogous to looking at a map of the United States that only displays roads and highways (i.e. no cities) and trying to identify where the cities are located based on the relative density of the roads.

[20] Note that this result might not be true in other types of networks where circular citations might be possible. Academic citations could present such a situation if two papers each cite the other. Such a citation pattern is impossible, however, in acyclic networks such as patent networks, and thus is not of concern here.

1. NBER Patent Citation Data

Testing these hypotheses requires examining actual patent data. Previous work by Hall, Jaffe, and Trajtenberg (Hall et al. 2001) collected detailed information on almost 3 million U.S. patents granted between January 1963 and December 1999 and all citations were made to these patents between 1975 and 1999 (over 16 million). This database was then made available by the National Bureau of Economic Research ("NBER"). The proposed methodology requires the use of two of the NBER patent data sets.

- A complete list of patents with designations of category, subcategory, and *n* class. These are contained in the SAS datafile pat63_99.tpt, available at http://www.nber.org/patents.
- A complete list of patent citations. These are contained in the SAS datafile cite75_99.tpt, available at http://www.nber.org/patents.

Within the NBER patent citation database, each patent is given two dimensions. First is the patent number, referred to as the *citing* value. The second value is the number of another patent to which the value connects, called the *cited* value. As is the nature of citation networks, the data are directional, always pointing from *citing* to *cited*.

2. Comparison of Network Densities

Once each subset of patents has been identified (i.e. pool, near universe, complete universe) and extracted from the NBER patent database, the particular subset of citing and cited pairs are extracted from the NBER patent citation database for each subset of patents, and the citing patents are numbered in ascending order. Once ordered, a count is taken of the number of cited entries per citing patent, $n(cited)$. Each patent in the list is then given a number, k, which represents the number of possible citations within the subset that are possible for the given patent. If n is the index number of the patent within the list, then $k=n-1$. The local unweighted density Δ_{np} is then calculated by dividing the number of actual citations by the number of citations possible for that patent, or $\Delta_{np}=n(cited)/k$.

After finding the local unweighted density, the weighted local densities of each patent are then calculated by multiplying the local unweighted density and the respective *k* value as a weight. The resulting list is used to calculate the standard deviation of the weighted densities using the *k* value as analytic weights. Using Formula (6), the weighted patent network density Δ_p is found by dividing the number of existing citations, $\sum n(cited)$, by the number of possible citations within the directed network graph, $g(g-1)/2$.[21] The same process is then repeated to generate a density measure for the surrounding patent space, and those two densities are then compared, with a statistically significant difference in density providing evidence of a patent thicket within a larger area of patent space.[22]

3. Shadow Pools

To assist in the validation of the network density measure Δ_p, the density of a given patent pool could also be compared against comparable "shadow pools," or collections of patents that match the pool on a number of dimensions. Formally, the development of the proposed shadow pools is accomplished in the following manner. Given a set of patents, A, numbered sequentially, a patent pool typically is a list of non-adjacent patents, B, drawn as a proper subset of the larger corpus.

$$B \subset A$$

For each pool patent *x* occupying a position in the set at position *i*, the corresponding patent in the *n*th shadow pool, B_n is the set of patents in A that is *n* positions away from *x*.

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[21] In practice, both the average density and the standard deviation for Formula (6) can be calculated using a statistical package that can use analytic weights, such as STATA Thanks to Bill Simpson, Senior Statistician at the HBS Faculty Research Computing Center for help on developing the appropriate analytic weights. In this instance, the analytic weight for each observation of local patent network density is the number of possible citations for the given patent.

[22] Since each patent network density value Δ_p is the average of the individual local patent densities Δ_{np}, a *t*-test is used to compare the two mean values. The results of the *t*-test indicate the probability of a random collection of patents drawn from the given patent space having a density measurement as high as or higher than the density observed in the pool.

$$B_n = \{x_{i+n} \in A, \forall i \mid x_i \in B_0\}$$

If set A is bounded by date, for example, the number of patents within the shadow pool will decrease as $|n|$ grows larger and deviates further from the original positions.

As an example of how a shadow pool is constructed, assume a simplified patent universe of six patents (221, 287, 357, 481, 518, 533, and 612) and a small pool B_0 of three patents (357, 481, and 533). The shadow pools drawn from the six-patent universe would be constructed as such.[23]

B_{-3}	B_{-2}	B_{-1}	B_0	B_1	B_2	B_3
221	221	221	221	221	221	221
287	287	287	287	287	287	287
357	357	357	357	357	357	357
481	481	481	481	481	481	481
518	518	518	518	518	518	518
533	533	533	533	533	533	533
612	612	612	612	612	612	612

Densities for these shadow pools can be compared against both the densities of the base pool B_0 as well as the density of the surrounding patent space A.

In order to demonstrate the utility of such an objective methodology for patent thicket identification, the next section presents brief case studies on the MPEG and PRK pools and incorporates calculations of patent thicket density in an examination of their widely divergent fates.

VI. A Tale of Two Pools

The first two patent pools to undergo antitrust examination after the issuance of the *IP Guidelines* were the MPEG and PRK pools. Although the two pools had a number of similar characteristics, the antitrust regime gave its blessing to the MPEG pool but destroyed the PRK

[23] Note that pool B_{-3} contains only two patents each because any prior patents exist in a time before the earliest patent in the base pool B_0. Similarly pool B_3 contains only two patents each because any later patents exist in a time after the most recent patent in the base pool B_0.

pool. This section reviews the history of each pool, examines their interaction with the antitrust regime, and then returns to the fundamental question of whether each pool was in fact coincident with an underlying patent thicket.

A. Patent Pool Formation

1. The MPEG Pool

The MPEG pool involves technology for digitally coded representation of moving pictures, audio, and their combination in compressed formats. One of the earliest innovators in this technology space was Leonardo Chiariglione, who convened the first meeting of the Moving Picture Experts Group ("MPEG") in January 1988. The MPEG working group (formally known as ISO/IEC JTC1/SC29/WG11) is part of JTC1, the Joint ISO/IEC Technical Committee on Information Technology, and is also part of the International Telecommunication Union Telecommunication Standardization Sector.[24]

These standard setting organizations are quite cognizant of the potential problem of patent thickets and have developed policies that are designed to prevent patent thickets from thwarting the adoption of standards-based technologies. For example, the ISO/IEC directives specify that all participants in the standard setting process must

> draw the attention of the [standard setting] committee to any patent rights of which it becomes aware during any stage in the development of the [standard. Once a proposal is accepted,] any holder of such identified patent rights [will be asked] for a statement that the holder would be willing to negotiate worldwide licenses under his rights with applicants throughout the world on reasonable and non-discriminatory terms and conditions. Such negotiations are left to the parties concerned and are performed outside ISO and/or IEC. … If the right holder does not provide such a statement, the committee concerned shall not proceed with

[24] The various standards bodies include the International Standards Organization ("ISO"), the International Electrotechnical Commission ("IEC"), and the International Telecommunications Union ("ITU"). The operation of these standards committee is carefully regulated by "Directives" issued by ISO/IEC and "Procedures for the Technical Work" issued by JTC1.

> inclusion of an item covered by a patent right in the document without authorization from ISO Council or IEC Council as appropriate.[25]

The ITU's Patent Policy similarly provides that the holder of any known patent or any pending patent application related to any proposal made to the ITU in the process of standards-setting must submit a written statement, either waiving those patent rights or committing to negotiate licenses for those rights on a non-discriminatory basis and on reasonable terms and conditions. [26] Such licensing provisions are often referred to as Reasonable and Non-Discriminatory, or RAND.

a) Developing the MPEG standard

Under the auspices of the ISO, the IEC, and the ITU, MPEG followed an international standards process aimed at achieving a standard that specified the coded bitstream and decoder requirements for high quality digital video and associated audio, including multiplexing multiple video, audio, and program information streams for transport or storage. The original goal of the MPEG committee was to create a standard for the delivery of video and audio on CD, and their original standard is known as MPEG-1.

Realizing the potential of digital compression technology to increase services and lower costs, distribution network industries such as cable television were intrigued by the MPEG concept but were interested in higher bandwidths than CD data rates. In response, MPEG developed a second standard, MPEG-2, that takes advantage of the higher bandwidths available to these networks to deliver higher image resolution and picture quality.

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[25] IEC Directives, Section 2.14.2, available at http://www.iec.ch/tiss/iec/Directives-Part1-Ed4.pdf

[26] *See* http://www.itu.int/ITU-T/dbase/patent/patent-policy.html

b) Patent Thicket Issues

Although the MPEG-1 standard was developed in 1989, the patent thicket challenges for the MPEG standards were not significantly addressed until after the release of the draft MPEG-2 standard in 1993, perhaps in part because of the interest of the cable industry. As mentioned previously, the IEC, ISO, and ITU all require that participants in the standard-setting process ultimately make available, on reasonable and non-discriminatory terms, any patent that is required to practice the standard. Given that the set of patents necessary to practice the MPEG-2 standard would come from a number of firms, in addition to the patent thicket issues, the potential problem of double marginalization (Viscusi et al. 2000) had to be addressed. As Leonardo Chiariglione put it, the challenge was inherent in

> the complexity of modern communication systems, where a large number of patents may be needed. … If the product, as in the case of the MPEG-2 standard, requires patents whose rights are owned by a large number of companies … and each company applies the fair and reasonable terms clause of the IEC/ISO/ITU patent policy, the sum of 40 fair and reasonable terms may no longer be fair and reasonable.[27]

As a result of the activities of informal meetings in 1992 and 1993 regarding intellectual property matters, a separate MPEG Intellectual Property Rights working group ("MPEG IPR") was formed to specifically address theses issues. Baryn Futa, Chief Operating Officer of Cable Television Laboratories, Inc. ("CableLabs") chaired the MPEG IPR working group which, in the course of its efforts, addressed issues such as: (1) how to identify which patent holders were willing to participate in this effort; (2) how to know whether they own rights necessary for implementation of MPEG-2 core technology; and (3) how to establish the entity's administrative structure as an ongoing effort that works with new licensees and licensers, the licensing structure, and the allocation of royalties.

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[27] Leonardo Chiariglione, "Communication standards: *Götterdämmerung*?" CSELT, Italy, available at http://www.chiariglione.org/leonardo/publications/standardisation

Once MPEG began to develop a standard for the higher bandwidths available to cable television companies, Baryn Futa took an active leadership role in the development of solutions regarding the patent thicket containing the core digital compression technology of MPEG-2. While Futa proclaimed that convergence around the MPEG-2 standard would provide a clear path to worldwide interoperability and serve to open the marketplace to multiple vendors, he also noted the difficulties posed by the patent thicket underlying the MPEG-2 standard.

> This great achievement has resulted in MPEG core technology that includes many different patents from many different companies and individuals worldwide. Unless a creative way is found to provide easy, reasonable, fair and nondiscriminatory access to such patents rights, the goal of a worldwide digital television standard may be jeopardized by the difficulty of clearing access to all the necessary patents.[28]

Early on, the MPEG-2 community agreed on the need for an innovative way to overcome the underlying patent thicket. Otherwise, the difficulty of gaining access to a large enough body of the necessary MPEG-2 patents would jeopardize the interoperability and implementation of digital video. Since any licensing negotiations were left to the parties concerned and were performed outside of the ISO and/or IEC standard setting process, several of the key companies participating in the MPEG process were concerned that patent rights clearances would be an issue. According to Futa, they believed that an effort should be started to explore the possibility of establishing a licensing entity to make access to the necessary rights easy and that such access be available on reasonable, fair, and nondiscriminatory terms. Ultimately the MPEG IPR working group recommended the establishment of a patent pool for MPEG-2 but separate from the operations of MPEG itself.

[28] http://www.cablelabs.com/news/pr/1995/1995_03_27.html

c) Patent Pool Formation

Following a series of meetings held in 1993 and 1994, the MPEG IPR working group reached a consensus on a two-phase action plan for establishing a licensing entity. The first phase specifically dealt with identifying the boundaries of the patent thicket underlying the MPEG-2 standard by asking companies to complete a form letter indicating their interest in working to create a licensing entity and to provide a list of their MPEG-related patents. The MPEG IPR working group decided that the mission of the patent pool licensing entity would be to foster fair, reasonable, and nondiscriminatory access to as much relevant IPR as is possible for the implementation of digital television. In the press release accompanying the announcement of the arrangement, Futa proclaimed "I hope that all companies and individuals worldwide who believe that they have important patent rights for MPEG core technology will join our effort to make MPEG a reality."[29]

The second phase involved the MPEG IPR working group arriving at an initial conclusion on a model for paying royalties on MPEG-related products such as digital encoders; digital decoders, including set-top boxes; DVD players; and prerecorded storage media such as video CDs, DVDs, and prerecorded magnetic media. A number of the participants had licensing arrangements in industries where the norm was a royalty-free cross-license; however, such provisions would only be mutually beneficial if all of the MPEG-2 participants were manufacturers. Certain participants, particularly Columbia University, were not manufacturers and therefore sought to have a monetary royalty imposed. The final royalty arrangement called for a $3 to $4 (U.S.) royalty paid on each digital decoder, including MPEG-2 set-top boxes and DVD players, and a fraction of that dollar amount paid as royalty on each video CD or DVD.

[29] http://www.cablelabs.com/news/pr/1995/1995_03_27.html

Once agreement had been reached about the creation and operation of the pool, Futa formed a licensing entity called MPEG LA, LLC, which would ultimately administer the patent pool for virtually all of the patents essential to the MPEG-2 standard.

d) "Essentialness" as a Proxy for the Patent Thicket Boundary

The challenge facing the newly formed licensing organization was daunting, but not insurmountable. Although there was consensus that the essential patents needed to be aggregated, no working definition of essentialness had been developed. Thus Futa was confronted with a classic chicken and egg problem. On one hand, "there was no absolute handle on what was the essential intellectual property."[30] On the other hand,

> there was no track record to go with it, so if you're going to [approach a firm and ask them to give you access to] one of their most precious assets, which is intellectual property, and say, "Don't worry … I can license this for you." [Their response would be,] "Well, have you ever done this before?" and of course, … the answer is no. If it had been done before, I wouldn't be asking you to do it now. [31]

While the new licensing entity, MPEG LA, did not have a track record of identifying essential patents, it did have a detailed written document that described the requirements for implementing the MPEG-2 standard. The *IP Guidelines* did not contain a working definition of either essentialness or patent thickets, but Futa developed a plan in conjunction with a patent attorney named Ken Rubenstein to develop an objective third-party process that would prove not only the existence of a patent thicket but could also define its boundaries in terms of an objective determination of essentialness.

The MPEG specifications, which contain thousands of pages, detail several elements that are absolutely required to practice the standard. In order to determine which patents were

[30] Interview with Larry Horn, March 9, 2004.

[31] *Id*.

essential, Rubenstein proposed to compare every independent claim from a given set of patents with the MPEG-2 specification and determine if the claim "read on" the specification. If so, the patent containing that claim would be deemed essential. Larry Horn describes the process as follows:

> Basically, if there was a "but for," if you couldn't do this spec of the normative part of the standard but for this independent claim, then the patent is essential. Very simple. Simple, but thorough, and not so easy to analyze. The point is that it's literally running down each independent claim and comparing it with a thousand or two thousand page stack that is available. If there was no such correlation between an independent claim and a patent, the patent is not essential.[32]

The MPEG specification did not, however, only specify exclusive requirements. Part of the specification allowed for some flexibility and for various alternatives in the implementation. Patents that only read on those provisions in the specification would not be classified as essential. Horn explains the importance of this determination by pointing out that the process must define

> four corners against which you can evaluate patents because you must have an absolute way to communicate to the market exactly what is in the license and what is not in the license. What qualifies to be in the license and what doesn't. This is not some cabal where people, because of the pedigree of their names, can have IP just because they happen to be named Sony or whatever. That doesn't qualify. You've got to have a patent that is a trespass across the property bounded by those four corners. The four corners, in this case, are defined by the MPEG-2 standard. [There may be some] important patents that might be outside of [those four corners, and we know of some that are] very valuable patents, [however] there has to be some "finiteness" to this. There must be some end to it.[33]

Another challenge facing MPEG LA was identifying the set of patents to compare against the standard. While those in the MPEG-2 process would have to abide by the RAND licensing

[32] *Id*.

[33] *Id*.

policies required by the ISO/IEC/ITU standards bodies, it was by no means certain that essential patents would be held only by those participating in the standard setting process.

> There were some pledges by people in connection with the MPEG-2 process … people stood up [and] said that if there's a license, to include them on the "fair, reasonable, non-discriminatory" terms to license my patent, et cetera, et cetera. Well, the shortcomings of those undertakings was [that] there was absolutely no reliability on who decided to raise their hand if they even had essential IP. It was just a random list in some respects of people who might want to cover their bases to be included on such a list.[34]

Such a list was still instructive, however, in that it was possible to refine the search by looking at the topics in the patents owned by the initial volunteers to identify relevant keywords. Another source of patents was to look at patents owned by particular parties who had self-identified by agreeing to the RAND commitment that was required in order to participate in the standard setting process.

With initial funding from CableLabs, Futa formally hired Rubenstein to conduct a massive study of the potentially relevant intellectual property throughout the world. Officially, the search did not produce a list of essential patents. The result of the search was, instead, a list of patent owners who might have essential patents. Based on that initial determination, those patent owners would then be approached to see if they were interested in submitting their patents for a formal determination of essentialness. For those parties whose patents were found to be essential, they could then join the patent pool and contribute those essential patents to the pool. According to Horn, the "study simply identified people that were worth targeting in order to try to persuade them that this was a cooperative effort worthy of their involvement."[35] Horn also notes some additional benefits of this process:

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[34] *Id*.

[35] *Id.*

> [It is] important to communicate what you have to licensees, so they know exactly what kind of product they're getting from the patent holders who are participating. It's important for licensors so they know the gating procedure and do some self-evaluation so they know if they have a patent that's "in" or not. Let's face it – it's important for the antitrust implications, not least of all, because the Justice Department and other authorities correctly want to make sure this is not some sort of "tie in" arrangement where, "Oh … that's nice … let's take these patents and also add the screws and all that kind of stuff." This is not that kind of an arrangement. This is a self-defined license that you can touch, feel, hear, understand, put your hands around, and if you're a little more technologically oriented, can follow Ken's evaluations and understand what he did. [36]

While the study involved examining more than 8,000 US patent abstracts, more than 1,000 US patents, and more than 80 US patent prosecution histories, it

> was not a definitive anything in terms of determining what was essential. It was a fishing expedition to try and cast a wide net to try to find out what might be essential, because we had the chicken and egg problem of getting these companies started so that people could go out and say, "Hey, play ball with us and submit a patent." … At the end of the day, this is purely a voluntary exercise on the part of every patent holder. We rely totally on a patent holder to submit its patent for evaluation. If they don't, we have no way of compelling its inclusion. So, we can't assure people that we include all essential IP, even if we strongly suspect that there is other IP out there. At the end of the day, the only thing that matters [is that] a willing party submits the patent for evaluation, in which case, that's the only evaluation that counts – is what was actually submitted for inclusion in this portfolio according to the terms of inclusion. [37]

Although MPEG LA had a formalized process, the prospects of getting potential pool members to submit their MPEG-relevant patents for evaluation and potential inclusion involved a certain level of uncertainty. In the laser eye surgery industry, however, the uncertainties were far more daunting.

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[36] *Id*.

[37] *Id*.

2. The PRK Pool

a) The Vision Correction Market

In the quest for improved vision, for most of the last several centuries, glasses were the only option. The development of the contact lens provided an alternative solution, but a portion of the vision-correction market wanted a permanent solution, and doctors began to develop surgical techniques for vision correction. The potential market for vision correction surgery was and is huge. In the United States alone, approximately 140 million people have vision problems, and most still correct their vision with contact lenses or eyeglasses. One of the first surgical vision correction techniques developed in the 1980s to address this market was radial keratotomy, or RK, surgery. A doctor performs the RK procedure by making a series of manual surgical cuts in the corneal surface to flatten the curvature of the cornea. Much of the ophthalmology establishment approached refractive surgery with a great deal of skepticism. The concept of operating on a normal cornea to correct refractive errors was considered repugnant to most ophthalmic surgeons.[38] By the late 1980s, however, RK had become an established and widely performed procedure. In 1994, approximately 325,000 RK procedures were performed.[39]

b) Emergence of PRK

Beginning in 1984, Dr. Charles Munnerlyn began to design and develop an excimer laser surgical system that could be used to perform clinical surgery on the human eye without the use of scalpels or manually cutting the cornea. For the next 12 years, Dr. Munnerlyn and a team that included Columbia University ophthalmologist Dr. Stephen Trokel worked to research, engineer, design, develop, and test their idea for a laser eye surgery device. Their efforts were also met

[38] TR 2078, 4531-4533.

[39] TR 3432.

with much skepticism, including from the head of the Ophthalmology Department at Columbia, who scoffed at the idea and thought it would never be a successful surgical procedure.[40]

Undaunted, Drs. Munnerlyn and Trokel partnered with a company called VISX to develop a system for the new procedure, which they called photorefractive keratectomy, or PRK. PRK showed tremendous promise for correcting nearsightedness and astigmatism. As with RK, the surgery would reshape the cornea, but instead of a surgeon's scalpel, PRK would use the excimer laser to reshape a part of the eye's cornea so that light focuses properly and images appear clearly. The excimer laser would remove extremely precise amounts of corneal tissue using light from the far ultraviolet end of the spectrum to break the chemical bonds of the molecules in the cornea without thermal damage to the surrounding tissue.

One of the primary obstacles to bringing PRK to market was obtaining FDA approval. Because a PRK device would be a medical device, VISX could not sell the device in the United States until it received FDA approval. Consequently, starting in 1987, VISX spent tens of millions of dollars on FDA-mandated clinical trials before the FDA granted approval in 1996.

c) Patent Thicket Issues

The commercialization of PRK faced another significant hurdle in the form of intellectual property issues. These issues arose because VISX was not alone in the laser eye surgery arena, as there were two additional firms developing laser refractive surgery devices, Summit Technologies and Taunton Technologies.

VISX and Taunton each had patents covering PRK. Taunton had patents from another Columbia University ophthalmologist, Dr. Francis L'Esperance, who happened to work one floor apart from Dr. Trokel. Dr. L'Esperance's '913 patents related to the use of ultraviolet laser

[40] TR 894-895.

radiation in corneal surgery, and his other patents covered methods and apparatus involving laser vision correction. When the '913 patent issued, VISX realized that its broad claims presented a serious threat to their business. The '913 patent was the first bramble in what would ultimately become the PRK patent thicket.

VISX had been assigned the application for Dr. Trokel's '388 patent which broadly claimed any use of ultraviolet radiation to change the optical properties of any eye by photodecomposition of the anterior surface of the cornea, but when the '913 patent issued, Dr. Trokel's application was still working its way through the USPTO. Although the '388 patents claims were broad, it appeared that the '913 patent would trump it under US intellectual property law. In response, Dr. Trokel amended his patent claims to provoke an interference with the '913 patent, and the USPTO initiated an interference proceeding on September 30, 1988. VISX and Taunton vigorously fought for more than a year but ultimately settled their dispute by merging on November 27, 1990, which ended the interference proceedings according to USPTO regulations. The merged entity continued on under the VISX name, and the '388 patent ultimately issued on April 28, 1992 in a manner that gave it priority over the '913 patent.

The merger of VISX and Taunton did not fully clear the patent thicket, however, as the patents owned by Summit Technologies potentially blocked VISX from implementing a PRK device. According to Josh Newberg, at the time a litigator at the FTC,

> With each of the firms vying for capital to finance the long lead time from prototype, through clinical trials, to FDA approval, Summit and VISX had to make educated guesses about the relative scope of each other's patent portfolios based on very limited information. The stakes were huge. If Summit was found to have a blocking position over VISX, it could exclude VISX from the marketplace altogether.[41]

[41] Interview with Josh Newberg, March 9, 2004. Prof. Newberg left the FTC after the VISX litigation and is now a professor at the University of Maryland.

In this instance the blocking situation was mutual, as VISX had patents that blocked Summit from fully implementing a PRK device, and vice versa (Newberg 2000). The two firms were asserting conflicting rights to various apparatus and method claims for performing ultraviolet laser corneal surgery and had initiated interference actions against each other with respect to those claims. This mutually blocking situation was all the more problematic because FDA approval was still four years away, and both firms were desperate to find venture capital. According to VISX CEO Mark Logan, the underlying patent thicket was suffocating both firms and "neither firm could raise any money without settling the patent issues."[42] While the patent thicket threatened to thwart the development of laser eye surgery altogether, both firms were eager to find a structure that would allow them to proceed with their FDA trials and ultimately bring a PRK device to market.

d) Patent Pool Formation

To solve their patent thicket problem, VISX and Summit formed a patent pool called Pillar Point Partners ("P3") on June 3, 1992. Summit contributed 7 patents to the pool, and VISX contributed 18 patents. Collectively, these 25 patents contained more than 500 method and apparatus claims. In the recitals to the agreement, the partners stated that

> Summit and VISX believe that full, vigorous and ongoing competition in the marketplace between themselves and between themselves and other business engaged in the market in which VISX and Summit compete, free of costly, time consuming, and uncertain litigation, is in their individual best interests and is in the best interest of the public at large.
>
> Summit and VISX believe that in the absence of [the proposed patent pool] they would engage with each other in expensive and time consuming patent proceedings and litigation of uncertain result regarding the ownership of the [patent claims] in dispute and the right of each of them to practice the subject matter defined by each Claim in dispute.

[42] Interview with Mark Logan, July 1, 2003.

> The uncertainty, cost and delay associated with such proceedings and litigation would substantially impede each of their respective efforts to develop and exploit [PRK technology] would likely discourage others from attempting to introduce this technology, and will delay each of their respective efforts to make the benefits of this technology available to the public at large.[43]

Under the terms of the patent pooling agreement, the partners set a fee that each firm would pay into the partnership each time either firm's machine performed a laser vision correction procedure. This per-procedure fee was fixed at $250.

Each time a PRK procedure was performed, P3 would receive the per-procedure fee irrespective of whether the device used was a VISX machine or a Summit machine. P3 would then distribute the royalties to VISX and Summit according to a predetermined formula.[44] The formula tended to pay a larger share of royalties to VISX, which was logical given the size and breadth of VISX's portfolio, although Mark Logan would later comment that VISX should have received an even larger share of the royalties but that those terms had been negotiated before he joined the company.[45]

The mechanism of enforcing the per-procedure fee was a keycard that was required to operate the laser. According to Mark Logan, the per-procedure fee was designed to allow VISX to lower the acquisition cost of the machines and to cover its R&D and clinical trial expenses. Absent the per-procedure fee, VISX would have had to charge approximately $4 million per machine "to recover [VISX's] investment on a certain number of machines that were thought the market would acquire. [If there were no per-procedure fee], there would be no ongoing income

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[43] Pillar Point Formation Agreement, obtained from the FTC archives as part of the FTC's trial exhibits (CX 45).

[44] The royalty distribution provisions are contained in Article 10 of the General Partnership Agreement, also part of CX 45.

[45] Logan Interview, July 1, 2003.

stream [for PRK, which] would discourage further investment."[46] Logan further noted that without the per-procedure fee, the higher entry price point would drastically reduce the size of the potential market because ophthalmologists were not accustomed to making large capital investments. Given that most of the potential early adopters "were refractive surgeons who were doing RK, there was no capital equipment cost with the RK[, so they would be reluctant to spend] $4 million to invest in this unknown, unproven procedure when you have a good one [such as RK] which costs you nothing."[47]

The per-procedure fee also had substantial economic benefits for VISX and Summit. As with the classic razor and razor-blade model, selling the PRK device at a discount meant that more ophthalmologists would have the machine and therefore more patients would be purchasing the procedure. When Alcon Laboratories was considering an acquisition of VISX in 1995, its analysis plainly stated that the "key to making money in the excimer laser market is not through the sale of lasers – but in the collection of a per patient 'user fee.'"[48]

In addition to imposing a per-procedure fee on PRK procedures performed with either VISX or Summit devices, the patent pool was authorized to grant licenses to third parties.[49] A number of firms were a few steps behind in the development of PRK devices, and those firms might be interested in such licenses. Both VISX and Summit, however, had to agree if such a license were to be extended. Although it appears that licensing discussions took place with a number of third parties, ultimately no third-party licenses were ever granted. Having cleared the

[46] FTC Hearing, TR 3418

[47] *Id*. At 3421.

[48] CX-182, p. 2.

[49] The third-party licensing provisions are contained in Article 7 of the Formation Agreement.

patent thicket for PRK for themselves, however, Summit and VISX returned to the marketplace and then competed vigorously against each other, including during the FDA clinical trial phase.

Summit received FDA approval in October of 1995 and VISX received FDA approval five months later. In 1996, the first full year of operation for FDA-approved PRK lasers, doctors performed approximately 70,000 PRK procedures in the United States, with prices for the procedure ranging from $1,500 to $2,250 per procedure. VISX and Summit continued to expand the PRK market as competitors, but they would soon be challenged by the antitrust enforcement regime based on their cooperative effort to clear the PRK patent thicket.

B. Antitrust Review

Any organization that is concerned about potential antitrust issues has the right to submit a proposed agreement or structure in advance to antitrust enforcement officials for evaluation. At the DOJ this process is called the Business Review Procedure.[50] The FTC has a similar procedure for issuing Advisory Opinions.[51] Preparing a request for *ex ante* antitrust review is both cumbersome and expensive, and many smaller companies do not submit such requests.

1. Antitrust Review of the MPEG Pool

Given the troubled history of patent pools, however, the management of MPEG LA was justifiably concerned about antitrust scrutiny. Fortunately, however, the proposed MPEG-2 pool would be evaluated under the recently enacted provisions of the *IP Guidelines*, which explicitly acknowledge that patent pools may provide pro-competitive benefits.

Having crafted as pro-competitive a structure as they thought possible, MPEG LA submitted its request for Business Review on April 28, 1997. The request outlined the pro-competitive benefits of the proposed solution to the MPEG patent thicket, including

[50] 28 C.F.R. § 50.6.

[51] 16 C.F.R. § 1.1 *et seq.*

- Reducing the uncertainty of the availability of patent licenses so that those who require a license to manufacture an MPEG-2 product are aware that such a license can easily be obtained; and
- Reducing the substantial cost for each prospective licensee of determining on its own the identity of essential patent holders from whom a license must be obtained.[52]

The MPEG request also outlined specific contractual provisions designed to avoid anticompetitive effects. As to patent thicket issues, the MPEG request also noted that extreme care had been taken to insure that the proposed pool includes only essential patents and that a structure had been devised both to remove from the program any patents later shown to be non-essential and to include at a later date any other patents that the process subsequently identified as essential.

The DOJ issued a Business Review letter on June 26, 1997, stating that it was "not presently inclined to initiate antitrust enforcement action against the conduct"[53] proposed by MPEG LA. While such language might seem to provide little comfort or certainty as to the permissibility of the proposed patent pool, in practice such language was sufficient to proceed with the proposed activity, as the DOJ would not proceed with an antitrust enforcement action unless "the actual operation of the proposed conduct proves to be anticompetitive in purpose or effect."[54]

The DOJ began its formal analysis of the proposed patent pool with an inquiry into the validity of the patents and their relationship to each other, stating that attempts to shield invalid

[52] Letter from Garrard Beeney to Joel Klein, April 28, 1997. Beeny's letter also addressed a number of contractual benefits aimed at reducing transaction costs and double marginalization, including reducing the royalties that likely would be payable if each essential patent holder licensed its patent(s) on its own; reducing the other transaction costs of licensees having to negotiate and execute multiple licenses; reducing the cost to essential patent holders of providing licenses, thereby allowing licenses to be offered at a lower price; and offering the same royalty to all interested licensees on non-discriminatory terms so that no entity manufacturing or selling MPEG-2 products will have a price advantage over any other entity as a result of entering into a patent license for MPEG-2 essential patents.

[53] Letter from Joel Klein, June 26, 1997, available at http://www..gov/atr/public/busreview/1170.htm

[54] *Id*.

or expired intellectual property rights would not withstand antitrust scrutiny. Assuming that all of the patents to be included in the pool were valid, and based on the representations of the complementary nature of those patents, the DOJ acknowledged that a package license for patents in a patent thicket "can be an efficient and pro-competitive method of disseminating those rights to would-be users."[55] In the case of MPEG, the DOJ indicated that it viewed the pool as a pro-competitive aggregation of intellectual property. The DOJ's comfort with that position was enhanced by the fact that MPEG LA had used an independent expert to determine which patents were essential to comply with the MPEG-2 standard, thus objectively defining the boundaries of the underlying patent thicket.

In analyzing the agreement itself and its anticipated effect on the market, the DOJ stated that the proposed arrangement did not raise any significant competitive concerns, although it did note that the agreement would fix prices. It discounted any potential harm, however, finding that "since the contemplated royalty rates are likely to constitute a ***tiny fraction*** of MPEG-2 products' prices, at least in the near term, it appears highly unlikely that the royalty rate could be used during that period as a device to coordinate the prices of downstream products."[56]

The MPEG pool ultimately became the "gold standard" for patent pool formation, and a number of subsequent patent pools were formed following the pattern set by MPEG. Each of those pools, however, was based on a standard. The lack of patent pool formation outside of the standards-based context may be due, in part, to the antitrust entanglements of the PRK pool, which did not have the benefit of a standard to demonstrate the existence of an underlying patent thicket.

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[55] *Id*.

[56] *Id* (emphasis added).

2. Antitrust Actions against the PRK Pool

Unlike MPEG LA, P3 did not submit its structure for antitrust review. Perhaps portending what was to come, the Alcon "VISX Acquisition Proposal" contained an ominous warning that foreshadowed the trouble ahead for P3, indicating that "Alcon has been advised that the Pillar Point partnership potentially could be challenged by the Federal Trade Commission (FTC) under US antitrust law."[57] Three years after that memo, and almost exactly two years after VISX received FDA approval to begin selling PRK devices in the United States, the FTC issued a complaint on March 24, 1998, alleging that Summit and VISX had violated the antitrust laws.

The FTC's complaint contained several assumptions, however, which were core to its argument. Contrary to the assertions of VISX and Summit, the FTC disputed the existence of an underlying patent thicket. Critical to this position was the FTC's belief that the Trokel '388 patent was invalid, asserting that it had been obtained fraudulently by withholding relevant information from the USPTO during prosecution. The FTC also implicitly assumed that VISX and Summit were no longer competing aggressively because of the existence of the P3 pool, despite the fact that the two firms were still competing with one another in the sale or lease of PRK equipment

Based on these assumptions, the FTC argued that price competition in the sale or lease of PRK equipment was restricted because, under the P3 agreement, the per-procedure fee functioned as a price floor. The FTC further argued that since each firm was obligated to pay $250 per use into the pool, neither had any incentive to lower the usage charge below that level, and that absent the P3 pool, VISX and Summit would have competed with each other on usage charges, resulting in lower prices to doctors and consumers for the use of each company's PRK

[57] CX 182, p. 4.

equipment. Finally, the FTC complaint alleged that P3 had an anticompetitive effect in the market for PRK technology licensing because of the restrictions on third-party licensing.[58]

The FTC sought an order requiring VISX and Summit to dissolve the patent pool and prohibiting the firms from fixing the prices that doctors must pay to use the firms' PRK lasers. In a statement issued at the time the complaint was filed, William J. Baer, Director of the FTC's Bureau of Competition, alleged that consumers had been "overcharged an estimated $30 million [in 1997] by the illegal activity of these two firms, [which] sought to exempt themselves from the forces of competition by monopolizing the market for laser eye surgery and increasing the price of this important new procedure."[59]

Faced with an aggressive and well-funded government agency, neither VISX nor Summit was in a position to put up much of a fight. Additionally, according to Mark Logan, VISX was not receiving its fair share of the benefit relative to the breadth of its patent portfolio and had therefore been interested in dissolving the P3 pool if the terms could not be modified.[60] Logan conceded, however, that dissatisfaction with the pooling arrangement was recent and that its formation had been vital in terms of bringing PRK to the marketplace.

VISX and Summit settled with the FTC in August, 1998, and agreed to dissolve the pool. The FTC continued to pursue the allegations against VISX that the Trokel '388 patent was invalid, but VISX ultimately prevailed in a decision by an administrative law judge in June of 1999. Despite the FTC's initial allegations of fraud before the USPTO, VISX was further vindicated when the USPTO issued a reexamination certificate reaffirming the validity of the

[58] The complaint also stated that P3 had not licensed its patents to any third-party manufacturers and any offers to license had been economically prohibitive.

[59] http://www.ftc.gov/opa/1998/03/eye.htm

[60] Logan Interview, July 1, 2003.

‘388 patent in September, 2000. The FTC then reopened the case and dismissed the complaint altogether in February 2001.

3. Scholarly Critiques of the Destruction of the PRK Pool

Could the PRK pool have been formed in such a way so as to survive antitrust scrutiny? Given the erroneous position that the FTC took on the ‘388 patent, VISX’s dissatisfaction with the pool’s economics, and the lack of a methodology for demonstrating the existence of an underlying patent thicket, the pool was likely doomed from the start. The approach taken by the FTC, however, is still subject to criticism, as many of the assumptions upon which it based its initial actions were shown to be suspect, which raises the question as to whether the FTC action was ultimately in the public interest. Former FTC litigator Josh Newberg later wrote that

> Although the Commission’s analysis of the Summit/PRK pool [was] well-considered and supported by evidence, there may [have been] other, perhaps equally, valid interpretations of the same patent relationships; interpretations which [would] yield very different legal results. If the Supreme Court pooling cases teach us anything, it is that in the realm of technology licensing, things are not always as they seem. In the case of PPP, one can look at the same patent pool and the same technologies and see … a pro-competitive agreement resolving [a patent thicket]. (2000, p. 27)

Newberg also noted that based on the uncertain scope of the pooled patents’ claims and the similar designs of the Summit and VISX machines,

> there may well have been a nontrivial basis for Summit to believe that it could have been blocked by one or more of VISX’s patents and vice versa. … It all depends on fairly small differences of opinion regarding the scope of 25 patents, most of which have never been tested in litigation. (2000. p. 27)

Carl Shapiro similarly raises two particularly thorny issues regarding patent thickets in analyzing the VISX and Summit result (2000). First, if the two firms reasonably believed that their respective patent portfolios blocked each other at the time they formed the pool, was such a belief sufficient to justify the formation of a pool? How hard were they required to look into the

validity of each other's patent claims before agreeing to form the P3 pool? Second, assuming that each firm believed it could,

> at considerable expense, delay, and risk, invent around the other's patents, should [they] be prohibited from forming a pool and [instead be] forced to attempt to invent around each other's patents, under the view that consumer might thereby enjoy the benefits of direct competition (although the product might be delayed, or never introduced, in the absence of the pool)? (2000, p. 136)

Shapiro also questions the FTC's insistence that a cross-license was a superior alternative to a patent pool, given that under the terms of the pooling agreement, Summit and VISX had "agreed that the pool would license their patents to third parties, something that a cross-license would not permit, unless it contained rather unusual sublicensing rights?" (2000, p. 136) In contrast, absent the patent pool, subsequent entrants would face an even denser thicket than either VISX or Summit faced, as any new entrant would have to negotiate two separate licenses in order to access the necessary PRK patents. If the new entrant only licensed patents from Summit, for example, any devices that they produced would likely be infringing on VISX patents. A patent pool would have eliminated this problem, but the cross-license between VISX and Summit did not.

In interviews with both current and former FTC litigators who worked on the case, absent the issue of the fraud before the USPTO regarding the Trokel '388 patent, both the *ex ante* and certainly the *ex post* arguments for breaking apart the PRK patent pool are somewhat tenuous.[61] When comparing the MPEG and PRK pools, Josh Newberg suggests that certain differences may have been a function of their respective industries. In examining the MPEG pool, Newberg notes that the pool members are huge firms with enormous resources whose main business

[61] Of the PRK pool litigation team members that I interviewed, only Josh Newberg is no longer with the FTC. Given the negative comments that Newberg received from former colleagues after publishing his article, I have chosen not to identify the names of current FTC employees.

> is not the licensing of these pooled patents, but rather, the manufacture and sale of telecommunications and consumer electronics hardware. … The pool members appear to have entered into the arrangement in order to establish a video compression standard, to profit from the network externalities of maximally diffusing the standard, and using the standard to sell more hardware in the market of the future. In order to establish MPEG as a standard, they availed themselves of mechanisms to reduce uncertainty. (2000, p. 28)

Newberg also notes that MPEG's independent expert review mechanism minimized the potential uncertainty regarding the identification of essential patents, in turn objectively defined the boundary of the underlying patent thicket.

In contrast, Newberg points out that VISX and Summit were small start-up companies that were trying to create a completely new industry based on a technological innovation.

> They faced a capital-intensive technology, a long product development cycle, massive regulatory barriers, and potentially ruinous patent infringement litigation. For Summit and VISX, the laser refractive surgery business was the only business, and a single adverse patent ruling -- or even the perception of vulnerability to adverse patent rulings -- could dry up their capital and put them out of business. (2000, p. 28)

Newberg also justifies their license fee arrangement, noting that instead of trying to recover their capital investment by charging high machine prices, VISX and Summit presented the marketplace with a substantially lower machine acquisition cost compared to the actual cost of the machine. To make up for the lower revenues from machine sales, Newberg argues that VISX and Summit were justified in using the per-procedure fee as a kind of metering device, "the more the machines were used, the more money Summit and VISX would make in procedure fees" (2000, p. 28).

Newberg also identifies the benefit of using "the pooling arrangement to reduce the risk of [patent] litigation, while continuing to compete on machine sales, and also as a way of hedging the risk that one firm would receive FDA approval later, or perhaps not at all" (2000, p. 28). Newberg excuses the absence of licenses to third-party manufacturers as probably reflecting

> a judgment that they can maximize revenue and recover their high development costs more quickly by using their technology exclusively, at least initially. As other firms gain FDA approval and bring out new differentiated machines, the strategy [would likely have shifted] toward licensing third parties and earning revenues from machine sales that would not otherwise have gone to Summit or VISX. (2000, p. 28-29)

Newberg concludes his lament by analogizing to the Japanese short story of *Rashomon*. The *Rashomon* problem is essentially that differing factual versions reflect self-interested advocacy rather than objectivity. If an antitrust agency has an effectively unlimited litigation budget, and promotions are obtained by winning by antitrust litigation cases, then the incentive to decline to litigate marginal cases is diminished. Without an objective assessment of the existence of a patent thicket, nothing stood in the way of vigorous FTC litigation. Given that the FTC ultimately lost on all of its litigated positions, Newberg notes that "nothing in the case law or current enforcement policy adequately addresses [the PRK] *Rashomon* problem" of uncertainty in determining the existence of a patent thicket (2000, p. 29). An objective methodology for proving the existence of a patent thicket could dramatically decrease that uncertainty.

C. Analytic Comparison

Although neither the DOJ nor the FTC specifically made an assessment of the existence or nonexistence of an underlying patent thicket, the DOJ was able to assume the existence of a thicket based on the procedures put forward by MPEG that were designed to evaluate the essentialness of patents submitted for pool inclusion. Was such an assumption necessary? Could the existence of a patent thicket be proven rather than merely assumed?

Given the reliance on a standard for the determination of essentialness, the DOJ's assumption was a safe one. In the case of PRK pool, however, the FTC appears to have incorrectly assumed that no thicket existed and proceeded accordingly. If the P3 had been able to

invalidate that erroneous assumption during the early phases of the FTC's investigation, could the destruction of the PRK pool been avoided? An analysis of patent network density for each pool and its surrounding universe provides an answer to these questions and demonstrates the potential utility of measuring patent thicket density.

1. Analyzing the MPEG Pool

The US patent numbers in the MPEG pool were downloaded from the MPEG LA website and imported into a file called MPEG Pool List, which was then used to extract a subset of complete patent records from the NBER patent file. Due to the nature of the available NBER data on between-patent citations, the calculations are limited to patents issued between the years of 1975 and 1999. In the case of the MPEG patent pool, there are four patents that fall outside the upper bound of this date range. Calculations for the MPEG pool were made with the exclusion of these four patents. Sixty-one intra-pool citations were also extracted from the patent citation file for use in calculating the patent network density of the pool, Δ_p. Using a software package called Pajek, it is possible to represent visually the MPEG pool and all of the intra-pool citations using a graphical technique called force-directed placement (Fruchterman & Reingold 1991), as shown in Figure 1.

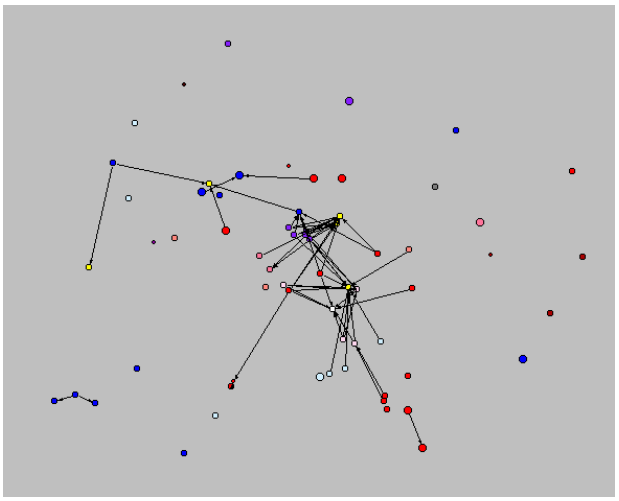

Figure 1. The MPEG Pool and Intra-Network Citations.

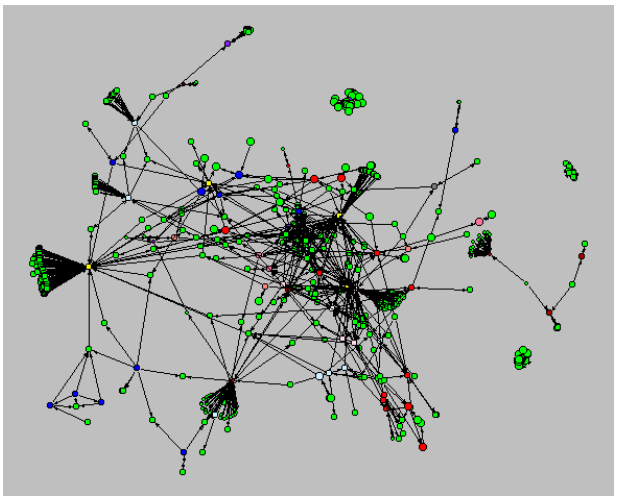

Figure 2. The MPEG Near-Universe and Intra-Network Citations.

a) Constructing the Complete Universe

Having downloaded the complete patent records for the MPEG pool, the next task was to construct a complete universe of citations based on the patent class memberships of the various MPEG patents. A total of nine 3-digit patent classes were represented in the MPEG pool,[62] and a list of patent records was extracted that corresponded to the time period defined as the range between the oldest MPEG patent and the youngest MPEG patent. This extraction resulted in an MPEG Class Universe of 72,761 patents. Using that set of patents as a set of network nodes, 501,346 intra-network citations were extracted from the NBER citation file for use in calculating Δ_p for the complete universe. For comparison purposes, similar "complete" universe examples were also generated using NBER constructed measures for technology subcategory[63] and category.[64] A final universe was also generated with only a time restriction.

[62] The MPEG patents came from patent classes 341,348, 358, 369, 370, 375, 382, 386, and 714.

[63] Subcategories 21, 22, 24, and 49.

[64] Categories 2 and 4.

b) Constructing the Relevant Near Universe

Even when limited to certain patent classes over a certain period of time, a complete patent universe can be quite large, as is evident from the size of the MPEG universe. For a given patent pool, a subset of the surrounding universe may provide sufficient differentiation to identify that the pool is coincident with a patent thicket. Construction of the nearby universe involves a technique called a "snowball sample." Starting with the list of patents, in this case the MPEG pool patents, citations are extracted from the NBER citation file for patents that either cite to a pool member or are cited by a pool member. As with the complete universe, in addition to a near universe based on the 3-digit patent classes corresponding to MPEG technology, near universes were also generated for technology subcategory and category. Patent network density values Δ_p were then calculated for each near universe. Using the same force-directed placement graphing technique as before, it is also possible to represent the MPEG pool visually within its surrounding near universe with all of the intra-network citations, as shown in Figure 2 above.

c) Comparison of Network Densities

Table 6 presents the various Δ_p calculations for MPEG and t-test results for average density comparisons.[65]

[65] For the t-tests, variance is not assumed to be equal.

Obs	Patents	Citations	Average Density Δp	Comparison of Δp against Δp for Obs 1	Obs 2	Obs 3	Obs 4
1	65	61	0.029327				
2	265	573	0.016381	0.0085			
3	935	3521	0.008064	< .0001	< .0001		
4	958	3598	0.007849	< .0001	< .0001	0.7177	
5	72761	501346	0.000189	< .0001	< .0001	< .0001	< .0001
6	335781	2203322	0.000039	< .0001	< .0001	< .0001	< .0001
7	790078	4519205	0.000015	< .0001	< .0001	< .0001	< .0001
8	1765311	10566170	0.000007	< .0001	< .0001	< .0001	< .0001

Table 6. Density Comparisons for MPEG.

- Observation 1: MPEG Intra-pool density. Only in-pool citations
- Observation 2: MPEG patent density within near universe (by *n* classes 341, 358, 369, 370, 375, 382, 386, and 714).
- Observation 3: MPEG patent density within near universe (by subcategories 21, 22, 24, and 49).
- Observation 4: MPEG patent density within near universe (by categories 2 and 4).
- Observation 5: Density of the patent universe through an *n* class window (by *n* classes 341, 358, 369, 370, 375, 382, 386, and 714).
- Observation 6: Density of the patent universe through a subcategory window (by subcategories 21, 22, 24, and 49).
- Observation 7: Density of the patent universe through a category window (categories 2 and 4).
- Observation 8: Density of the patent universe through a time window (no category, subcategory, or class restriction).

As is evident from Table 6, the density of the MPEG patent pool is statistically differentiable from any of the three near universe densities as well as any of the four complete universe densities.

Two MPEG shadow pools were also created. The first shadow pool was constructed by iterating through each MPEG patent in the pool and selecting the next sequential patent from the MPEG Class Universe. A second shadow pool was created by selecting the patent immediately preceding each MPEG pool patent.[66] Intra-pool citations were then extracted from the NBER citation database for each of these shadow pools to facilitate Δ_p calculations. When the densities

[66] Each of these shadow pools has one less patent than the MPEG pool, as shifting forward or backward by one patent results in the truncation of either the earliest or latest patent, since the time period for this analysis is defined as beginning with the oldest MPEG patent and ending with the youngest MPEG patent.

from the two shadow pools were compared against the complete universe, however, they were not statistically different from the complete *n class* universe (Observation 5).

2. Analyzing the PRK Pool

The list of PRK patents was developed from the FTC complaint, and a set of patent records was extracted from the NBER patent database. Using the same methodology as with the MPEG pool, patent networks were created for the PRK pool, the universe near the PRK pool, and a complete universe based on the two 3-digit patent classes[67] that covered the PRK pool, one each for the NBER- constructed variables of technology subcategory[68] and category,[69] and one universe with no technological constraint. Table 7 presents the various Δ_p calculations for PRK:

Obs	Patents	Citations	Average Density Δp	Comparison of Δp against Δp for Obs 1	Obs 2	Obs 3	Obs 4
1	25	61	0.20333				
2	197	1324	0.06858	0.0069			
3	239	1548	0.054428	0.0032	0.0837		
4	259	1602	0.047948	0.0023	0.0085	0.3375	
5	17138	188601	0.0012843	0.0002	< .0001	< .0001	< .0001
6	87205	902621	0.0002374	0.0002	< .0001	< .0001	< .0001
7	204199	1452254	0.0000697	0.0002	< .0001	< .0001	< .0001
8	1765311	10566170	0.0000068	0.0002	< .0001	< .0001	< .0001

Table 7. Density Comparisons for PRK.

- Observation 1: PRK Intra-pool density. Only in-pool citations
- Observation 2: PRK patent density within near universe (by *n* classes 351 and 606).
- Observation 3: PRK patent density within near universe (by subcategories 32 and 39).
- Observation 4: PRK patent density within near universe (by category 3).
- Observation 5: Density of the patent universe through an *n* class window (by *n* classes 351 and 606).
- Observation 6: Density of the patent universe through a subcategory window (by subcategories 32 and 39).
- Observation 7: Density of the patent universe through a category window (category 3).
- Observation 8: Density of the patent universe through a time window (no category, subcategory, or class restriction).

[67] Patent classes 351 and 606.

[68] Subcategories 32 and 39

[69] Category 3

The numerical analysis of the PRK pool leads to the conclusion that the PRK pool is coincident with a thicket, as does a visual examination of renderings of the PRK pool network and its nearby universe, as shown in Figures 3 and 4.

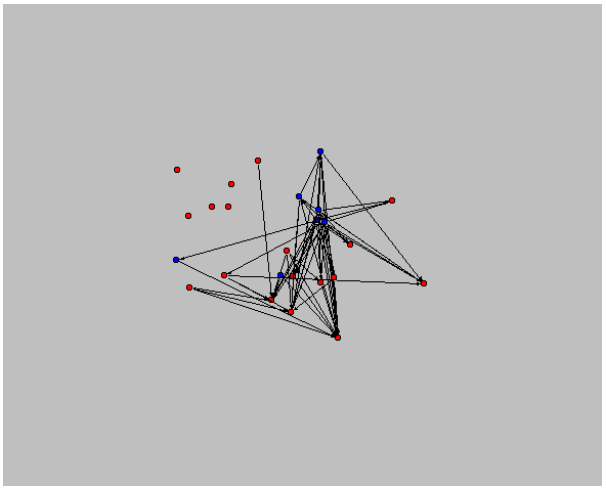

Figure 3. Laser Eye Surgery. PRK Pool Intra-Network Citations.

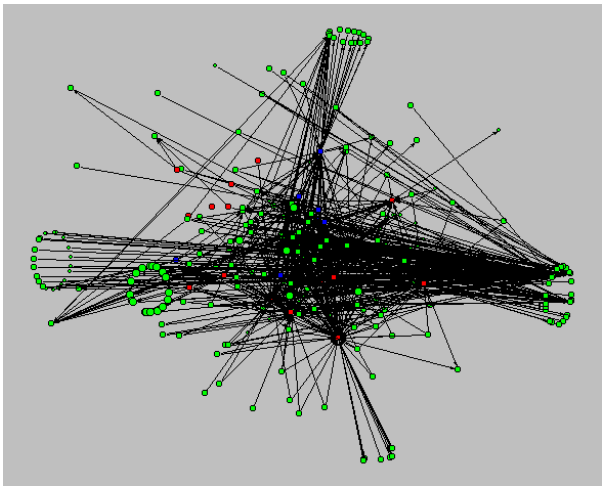

Figure 4. Laser Eye Surgery. The PRK Pool's Near-Universe.

3. Potential for False Positives

One issue that should be addressed involves whether in certain cases many cross-citations exist in the absence of a surrounding thicket. Cross-citation patterns of varying density will exist within patent space, and higher density areas may or may not be thickets. Shapiro's definition of a patent thicket is driven by an applied market interpretation concerned with the implications of patent groups for antitrust scrutiny. The proposed methodology assumes that market forces lead to the formation of a patent pool, and that the citation patterns present in the pool would also be present in a patent thicket even in the absence of a pool. Thus, while there may be areas of higher patent network density that have not been aggregated into a pool, Shapiro's definition suggests, and the analysis thus far confirms, that patent pools are coincident with underlying patent thickets. For those areas of higher density that have not been aggregated into pools, organizations

such as MPEG LA views such areas as market opportunities that it would like to be in a position to exploit, if only it had a methodology that allowed it to do so.[70]

VII. Lessons Learned

The MPEG and PRK pools were similar in many respects. They were both formed around emerging technologies in order to facilitate adoption of those technologies. They were also both formed around a collection of blocking and complementary patents. Their licensing provisions specified a fixed price that, while profit maximizing,[71] was only a small fraction of the total cost of the larger product. The relatively "tiny fraction" represented by the licensing fee was highlighted in the MPEG review[72] but did not deter the FTC from proceeding with litigation.

Ultimately, the MPEG patent pool appears to have survived the antitrust examination for two primary reasons. First, MPEG appears to have specifically crafted their pooling agreements in order to avoid antitrust problems. According to Larry Horn, each provision was designed so as to minimize the potential for any anticompetitive harm.[73] MPEG had a roadmap for making such determinations, however, as the *IP Guidelines* were issued two years prior to the finalization of the MPEG structure, and the MPEG protagonists had been following the development of the guidelines from early on. In contrast the PRK pool did not have such a roadmap when it was formed in 1992, three years before release of the *IP Guidelines*; therefore P3 was not attuned to what turned out to be "hot-button" issues for antitrust enforcement officials.

Second, and certainly equally important, MPEG LA was able to develop an objective process that demonstrated the existence of a thicket coincident with the proposed pool. As

[70] Horn Interview, March 9, 2004.

[71] Horn Interview, March 9, 2004, Logan Interview, July 1, 2003, and FTC Hearing, TR 3418.

[72] Letter from Joel Klein, June 26, 1997, p. 11. ("[S]ince the contemplated royalty rates are likely to constitute a ***tiny fraction*** of MPEG-2 products' prices, at least in the near term, it appears highly unlikely that the royalty rate could be used during that period as a device to coordinate the prices of downstream products." Emphasis added.)

[73] Interview with Larry Horn, March 9, 2004.

discussed earlier, however, that objective process was fundamentally dependant on the existence of a standard, and thus such a process was not available to the PRK pool (or any potential pool that might be formed outside of the standards-based context). It appears that the lessons to be learned from their widely divergent experiences relate more to the differences between the pools in terms of their respective abilities to demonstrate the existence of an underlying patent thicket, given the similarities of contract structure between the two pools.[74] Those differences can be clustered into two groups, process differences and the impact of standards.

A. Process Differences for Thicket Identification

Although creators of both the MPEG pool and the PRK pool realized that collective action was necessary for technological survival, economic survival was only a factor for the PRK pool. The founders of the MPEG pool were not desperate, nor were they seeking venture funding for MPEG-specific activities. In contrast, neither Summit nor VISX would ever have brought a product to market had they not cleared the underlying patent thicket. The differences between their respective processes, however, are quite significant.

MPEG used a third party arbiter to determine the boundaries of the patent thicket, which in turn determined which patents should be included and which should be excluded from the pool. VISX and Summit merely aggregated their respective portfolios into the pool.

The PRK pool did have an opportunity to seek approval for the pool from either the DOJ or the FTC, but for some reason chose not to. MPEG, on the other hand, put together an extensive package in its request for a Business Review Letter from the DOJ. Given the potential harshness of antitrust remedies, it appears that the standard notion that "it is easier to ask forgiveness than ask permission from a bureaucracy" is inapposite in the antitrust context.

[74] The availability of independent licensing is a potentially notable difference. The relative lack of importance of this difference, however, is discussed in part VII.B below.

B. The Impact of Standards on Thicket Identification

Although the process differences between the formation efforts behind each pool are significant, perhaps even more important are the lessons to be learned regarding the impact of standards on patent thicket identification. By default, the standards-setting process produced a written document that could be used to delineate the boundaries of the underlying patent thicket for the MPEG pool in terms of essential patents.

The identification of essential patents is a valid method for demonstrating the existence of an underlying patent thicket, but it requires the availability of a written standard to compare against. No such standards document exists for laser eye surgery, and thus that method of verifying the existence of an underlying patent thicket was unavailable for the PRK pool.

This lack of ability to unambiguously identify the essential patents that formed the underlying patent thicket was a huge problem for the PRK pool as, unlike the MPEG pool, it could neither point to a definition of essentialness, nor could it point to a third party that had made the essentialness determination. The PRK pool thus did not have a method for proving the existence of an underlying patent thicket, and the history of patent interference and infringement litigation in the laser eye surgery industry did not convince the FTC, or at least did not appear to impede its aggressive antitrust enforcement activities against the PRK pool.

Even some of the contract structure differences between the MPEG pool and the PRK pool are related to standards. The FTC complained that neither VISX nor Summit were free to license their respective patents independently, while the DOJ commended MPEG for incorporating just such a provision. The existence of that provision for the MPEG members, however, was in fact a contractual obligation imposed as part of the standards-setting process. The ITU/IEC process as well as the ITU process require that participants in the standard-setting meetings contractually agree to negotiate worldwide licenses for their respective patents with

applicants throughout the world on reasonable and non-discriminatory terms and conditions. That contractual agreement would preclude a PRK-style veto right in a pooling agreement. Lerner and Tirole note, however, that independent licensing is irrelevant in the case of a welfare enhancing pool (2002).[75]

The apparent necessity of standards for successful pool formation is somewhat troubling. Lerner and Tirole also suggest (2002), and my own historical analysis confirms, that the requirement that only essential patents be included in a patent pool is a recent addition to antitrust doctrine, and thus little case law exists to provide guidance as to how essentialness can be assessed. Although using a technology standard to evaluate essentialness appears to have succeeded, what should happen in industries that do not have standards-setting bodies such as the ITU?

Other than suffering through withering litigation, how could a pool survive that aggregates blocking patents without a technology standard? The PRK pool provides such an example. VISX and Summit argued that the PRK pool circumscribed an underlying patent thicket, but the FTC disputed the existence of the thicket. In the final analysis of the patents in the PRK pool, the reexamination certificate for the '388 patent upheld its validity and the scope of its claims, and so in hindsight, the PRK patent pool was in fact a pro-competitive solution to an underlying patent thicket.

The chilling effects of the coerced PRK pool breakup have caused ripples throughout the intellectual property arena. Organizations that might benefit from a patent pool are likely hesitant to incur the transaction costs associated with forming a patent pool given the uncertainty of its

[75] A pool is welfare enhancing when the pool price is less than the aggregate of individual licenses for complimentary and/or blocking patents.

antitrust survival. The only patent pools that have survived since the *IP Guideline*s have all been based on international technology standards. Those surviving pools include:

- MPEG
- MPEG-4
- DVD Disc
- DVD Player
- DVB-T
- IEEE-1394
- MP3

Additionally, three additional pools are forming, but they too are based on standards.

- 3G Wireless
- H.264 JVT/ AVC
- VC-9

The lone identified attempt to form a patent pool without a technology standard after the destruction of the PRK pool has been MPEG LA's recent effort to develop a patent pool for digital rights management ("DRM"). Although a DRM standard does not exist, MPEG LA has developed the equivalent of a standards document which they call a "Reference Model." According to Larry Horn, "this reference model will drive the evaluation of essentialness in much the same way that the standards specification drove the process for the identification of essential MPEG patents."[76] It is unclear how the antitrust regime will view the DRM pool. The fact that MPEG LA will use the same process as before, albeit with a reference model instead of a standard, may help the DRM pool survive, but that remains to be seen.

C. Analytic Conclusions

Although there are identifiable differences between the pools, an objective analysis, both of their contract provisions and the nodal interrelationships between their respective patents, indicates that they are not necessarily that different. As mentioned previously, the primary

[76] Interview with Larry Horn, March 9, 2004.

difference appears to be the existence of a technology standard in the case of the MPEG pool versus the absence of such a standard in the case of the PRK pool. The availability of the standard allowed MPEG to point to a third party determination of the existence of a patent thicket, while the patent thicket underlying the PRK pool was only proven after years of prohibitively expensive litigation.

This result is not necessarily surprising given the relative paucity of examinations of patent interrelationships in the legal case histories. In those cases, the overriding factor in most of the decisions was the presence or absence of restrictive licensing terms. Gilbert found a similar contractual focus in the cases he reviewed (2002), even though he makes a strong argument that the competitive relationships between the patents should be the most important factor in assessing the pro-competitiveness of a given pool.

From a patent density standpoint, the analysis in Part VI.C. demonstrates that both the MPEG pool and the PRK pool were coincident with patent thickets. If the antitrust regime were to adopt an objective methodology for identifying the existence of underlying patent thickets, patent pools formed outside of the standards-based context might have a chance at survival.

D. Likelihood of an Alternate Outcome

Given the proposition that the PRK pool was ultimately destroyed because the pool was unable to demonstrate the existence of an underlying patent thicket, it seems appropriate to pose the same question that was asked about the historical litigation: "Would the availability of an objective methodology for determining the existence of a patent thicket have made any difference for either the MPEG or PRK pools?" In the case of MPEG, such a methodology would have only confirmed what the DOJ was already willing to accept, that the process for determining essentialness also defined the boundaries of the underlying patent thicket. In the

case of the PRK pool, however, the answer is a resounding "YES!" The admissions of former and current FTC litigators involved in the case clearly demonstrates the point that, absent the allegation of fraud regarding the '388 patent, the patent pool would probably not have been attacked. With an objective confirmation of the existence of an underlying patent thicket, however, even if the FTC legitimately believed that the Trokel '388 patent was invalid, it could have left the pool intact and could have instead focused on challenging the patent. If the '388 patent were ultimately found to be invalid, then it could have been pulled from the pool, a remedy that seemed to satisfy the DOJ in its review of the MPEG pool. [77]

While the FTC's actions to force VISX and Summit to enter into a cross-license did not allow the PRK patent thicket to reform relative to VISX and Summit, it did nothing to solve the patent thicket problem relative to new entrants. In fact, the relative litigation peace that the patent pool facilitated was shattered when it dissolved. According to Mark Logan, no less than six infringement suits were subsequently initiated because of conflicting claims about both PRK and a new, emerging procedure called LASIK,[78] which shared some of the core technological requirements potentially covered by the VISX and Summit patent portfolio.[79] Summit was so damaged by the litigation that it was quickly acquired by Alcon, and any potential new entrants such as Nidek faced the prospects of negotiating licenses with multiple potential competitors before they could break into the market.[80]

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[77] Letter from Joel Klein, June 26, 1997, footnote 40. ("The Department presumes from the information you have provided us that the Portfolio patents are valid. Should this prove not to be so, the Department's analysis and enforcement intentions would likely be very different. As noted above, the Agreement Among Licensors provides for the deletion from the Portfolio of licenses held invalid or unenforceable.")

[78] LASIK stands for Laser-Assisted *In situ* Keratomileusis.

[79] Interview with Mark Logan, July 1, 2003.

[80] *Id*. Interview with Doug MacHatton, Vice President, Investor Relations, Alcon Laboratories, Inc., July 3, 2003.

The FTC's fixation on the third-party licensing veto seems rather misplaced given that the FTC forced the substitution of a cross-license. Any subsequent third party that wanted each set of patents would not be able to gain access to all of the essential patents without both VISX and Summit each agreeing to license their respective portfolios.

The availability of an objective methodology for determining the existence of an underlying patent thicket could have eliminated the *Rashomon* problem altogether. In terms of patent thicket questions, there would have been no differing factual versions to reflect self-interested advocacy because the question of the existence of the underlying patent thicket would have been objectively answerable. As Newberg notes, currently "nothing in the case law or current enforcement policy adequately addresses [this] *Rashomon* problem" (2000, p. 29), but an objective methodology for proving the existence of a patent thicket could have fundamentally altered the course of the litigation, left the pool in place, and produced a better outcome in terms of social welfare.

VIII. Discussion

A. Contributions

In proposing an objective methodology for the determination of the existence of patent thickets, this paper makes a number of contributions to both the intellectual property and antitrust regimes. It also adds a third component to the antitrust analysis of patent pools beyond contract structure and market dynamics by facilitating an inquiry into the existence of an underlying patent thicket. The methodology also provides a potential mechanism for allocation of antitrust enforcement resources. Finally, the methodology provides an alternative method of thicket identification in instances where a technology standard is not available.

The antitrust enforcement regime often uses thresholds to allocate enforcement resources. A prime example is the use of the Herfindahl-Hirschman Index ("HHI") of market concentration.

The incorporation of the HHI into the antitrust regime shifted the analysis of horizontal mergers from one of intent, highly subjective and often difficult to assess conclusively, to one of objectively determinable market characteristics (Viscusi *et al.* 2000). "Mergers resulting in unconcentrated markets[, HHI index below 1000,] are unlikely to have adverse competitive effects and ordinarily require no further analysis" (USDOJ 1992, § 1.51(b)) even if the merging parties have evil intent. Conversely, mergers involving angelic participants with no ill intent whatsoever will be examined thoroughly if they substantially alter the HHI in a highly concentrated market (i.e. more than a 50 point change in a market with an HHI greater than 1800).[81]

The thicket identification methodology would allow antitrust enforcement officials to narrow the set of issues that need to be examined for a patent pool if the existence of an underlying patent thicket can be demonstrated, as combinations of patents that are not coincident with an underlying patent thicket are unlikely to be welfare enhancing and thus deserve heightened scrutiny and detailed examination of contract structure. Using the PRK pool as an example, if the existence of an underlying patent thicket could not be demonstrated, then the FTC could proceed as it did, disbanding the pool and then litigating additional allegations of antitrust violations.

If, however, the proposed methodology produced an objective determination that the PRK pool was coincident with a patent thicket, such combinations are more likely to be welfare

[81] There is, however, a fundamental difference between the proposed methodology for patent thicket identification and the HHI, at least for the moment. The threshold levels of the HHI are applied across industries. Thus a post-merger HHI of 1900 indicates a highly concentrated market regardless of industry. This paper does not assume that the density of one thicket can be compared to the density of another. What is suggested is that given an area of patent space, the density of patent thickets, like the relative brightness of stars in the night sky, makes them differentiable from the background patent space. Further research may, however, ultimately lead to the development of threshold levels for the evaluation of patent thicket density, which would facilitate density comparisons between industries.

enhancing and the FTC could narrow its analysis and focus its efforts on challenging the validity of the Trokel '388 patent, leaving the pool intact during the litigation. If the patent's validity was upheld, the case could be dismissed, given that Lerner and Tirole have demonstrated that independent licensing is not as important for welfare enhancing combinations (2002), and the per-procedure fee constituted only a small fraction of the overall procedure price. If the patent were found to be invalid but a subsequent analysis of the remaining pooled patents showed that a patent thicket still existed, the FTC could still have crafted a remedy leaving the pool intact.

Finally, the objective determination of an underlying patent thicket would allow the FTC to allocate resources to the determination of BCIS relationships within the patent thicket itself. The *IP Guidelines* identify the inclusion of substitutes in a pool as being anticompetitive, but the difficult determination of the BCIS relationships need only be undertaken if the existence of an underlying patent thicket is proven first.

In terms of pools yet to be formed, although it appears that standards-based pools such as the MPEG-2 pool have an alternative methodology available for demonstrating the existence of an underlying patent thicket, that alternative requires the existence of a written standard. The development of a zone of essentialness is not possible for pools formed without the benefit of a standard since there is no objective benchmark of what constitutes an essential patent. For those pools, the proposed methodology is an alternative that does not require the existence of a standard. Were the antitrust regime to acknowledge the validity of the proposed methodology, the chilling effect of the PRK pool litigation could be reversed, and the antitrust regime might warmly receive proposals for pool formation from outside the standards-based context. In the case of MPEG's proposed DRM pool, the proposed methodology could be used to bolster MPEG LA's position that incorporating the reference model into its process for determining

essentialness produces the same result from a patent thicket standpoint as does the use of a technology standard.

B. Limitations

As with the aphorism "All poodles are dogs, but not all dogs are poodles," from a policy standpoint, all patent pool members may fall within a patent thicket, but not all patent thicket members should be allowed in pools. Therefore, whereas density seems to be a sufficient measure for thicket identification, a different type of analysis is needed in order to identify whether or not a patent pool is a pro-competitive solution for a given set of patents in a thicket. In order to assess the pro-competitive benefits of a given patent pool, it is necessary to peer inside the patent thicket and determine how the individual patents relate to each other. This determination requires an assessment of the BCIS relationships, which the proposed methodology for patent thicket identification cannot address.

While the proposed methodology facilitates a determination of whether or not a given pool satisfies the necessary condition that an underlying patent thicket exists, as mentioned previously that condition is necessary but insufficient. Since there are still potential anticompetitive harms from patent pooling (Priest 1977), the antitrust enforcement regime should not automatically approve any pool submitted for review, particularly in light of the anti-competitive history of patent pooling in the first half of the 20th century (Carlson 1999; Gilbert 2002), even if the proposed pool can be demonstrated to be coincident with an underlying patent thicket. The elimination of substitutes is also a necessary but insufficient condition for a pool to be pro-competitive.

Although the proposed methodology does not attempt to assess the BCIS relationships within a patent thicket, this paper is the first attempt to objectively demonstrate the existence of

patent thickets. Without first verifying the existence of a given thicket, any attempts to objectively segment a thicket into BCIS categories would likely be futile. Answering the question of thicket existence is thus a first step toward empirical usefulness of the theoretical BCIS framework. The proposed methodology thus provides a foundation for further exploration of the nature of patent thickets and the development of policies to facilitate the formation of pro-competitive patent pools to solve the problem posed by patent thickets.

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