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INNOVATION ECONOMICS: THE INTERPLAY AMONG TECHNOLOGY STANDARDS, COMPETITIVE CONDUCT, AND ECONOMIC PERFORMANCE

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ABSTRACT

Industries with technological standards can be highly competitive and innovative. The modern approach to Innovation Economics understands that technology standards, the competitive conduct of firms, and the economic performance of innovative industries are endogenous and jointly determined. Market competition and standards organizations endogenously determine technology standards, which are consistent with innovative efficiency. This contrasts with traditional Innovation Economics, which can be summarized as a "Standards-Conduct-Performance" paradigm. The traditional view, which is reminiscent of the traditional Industrial Organization "Structure-Conduct-Performance" paradigm, incorrectly assumes that technology standards are exogenous and cause imperfectly competitive conduct and inefficient economic performance. Instead, studies of innovation should apply game-theoretic models that account for strategic interaction and empirical tools that control for the interplay among technology standards, competitive conduct, and economic performance.

JEL: D40; O31; L10

I. INTRODUCTION

Modern Innovation Economics (IE) offers a fundamental insight: technology standards, the competitive conduct of firms, and the economic performance of innovative industries are *endogenous and jointly determined*. This implies that technology standards generally do not confer market power on intellectual property (IP) owners because of the strategic interaction of innovative firms,

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the introduction of further innovations, and the development of new standards. Technology standards affect the competitive conduct of firms and the economic performance of innovative industries including innovative efficiency. However, the competitive conduct of firms and the economic performance of innovative industries affect the determination of technology standards through market competition, standards organizations, and government regulation. These dynamic feedback effects have significant implications for antitrust policy and public policy toward innovation and IP. The dynamics of standard setting tend to promote competition and innovative efficiency.

This more realistic view of innovative dynamics represents a shift away from traditional IE, which is based on what I term the "Standards-Conduct-Performance" paradigm. The "Standards-Conduct-Performance" paradigm takes technology standards as *exogenous* once they are established.[1] The traditional IE paradigm suggests that public policy makers and researchers can draw a line of causation from technology standards to IP owners' competitive conduct, and, in turn, from IP owners' competitive conduct to innovative efficiency. According to this perspective, technology standards "necessarily" confer substantial market power on owners of Standard-Essential Patents (SEPs).[2] The traditional IE approach yields flawed public policy recommendations because it

[1] *See, e.g.*, Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, *in* 1 INNOVATION POLICY AND THE ECONOMY 119, 128 (Adam B. Jaffe, Josh Lerner & Scott Stern eds., Nat'l Bureau of Econ. Research 2001) ("standard setting very often has especially strong elements of both the complements problem and the holdup problem."); Mark R. Patterson, *Inventions, Industry Standards, and Intellectual Property*, 17 BERKELEY TECH. L.J. 1043, 1044 (2002) ("Some of the demand for products that comply with the standard may be for the inherent technical advantages of the invention. A patentee is generally entitled to revenues attributable to this demand. But some of the demand may also be created by the adoption of the standard. The patentee is not entitled to revenues attributable to this demand."); Daniel G. Swanson & William J. Baumol, *Reasonable and Nondiscriminatory (Rand) Royalties, Standards Selection, and Control of Market Power*, 73 ANTITRUST L.J. 1, 4 (2005-2006) ("there is the risk that the standard-setting process may itself be utilized to confer market or monopoly power beyond that contemplated by the intellectual property laws, which, in turn, may distort competition, impede technological dissemination and yield returns to innovation that are *too high*." (emphasis in original)); Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991, 2016 (2007) ("These problems of holdup and royalty stacking can be severe in the case of private standard setting."); Joseph Farrell, John Hayes, Carl Shapiro & Theresa Sullivan, *Standard Setting, Patents, and Hold-Up*, 74 ANTITRUST L.J. 603, 607 (2007) ("Ex ante, before an industry standard is chosen, there are various attractive technologies, but ex post, after industry participants choose a standard and take steps to implement it, alternative technologies become less attractive. Thus, a patent covering a standard may confer market power ex post that was much weaker ex ante.").

[2] *See, e.g.*, Kai-Uwe Kuhn, Fiona Scott Morton & Howard Shelanski, *Standard Setting Organizations Can Help Solve the Essential Patents Licensing Problem*, 3 COMPETITION POL'Y INT'L CPI ANTITRUST CHRON. (SPECIAL ISSUE) (2013) ("SSOs constrain the license terms for SEPs because of the substantial market power necessarily enjoyed by the owner of an SEP in a successful standard.").

fails to take into account dynamic interactions among standard setting, competitive conduct, and economic performance in innovative industries.[3]

Economists, legal scholars, and public policy makers will immediately recognize similarities between the shift from traditional to modern IE and the earlier shift from traditional to modern Industrial Organization (IO). Traditional IO tended to follow the "Structure-Conduct-Performance" paradigm. Given an exogenous industry structure—the number and size of firms—traditional IO scholars and public policy makers sought to predict whether an industry would conduct itself in a competitive or monopolistic manner, and thus inferred that the industry would exhibit efficient or inefficient economic performance (shown by Figure 1A). In particular, traditional IO viewed a concentrated market structure as the cause of market power and inefficient economic performance. This approach guided many legal cases and influenced antitrust policy. Traditional IO and the "Structure-Conduct-Performance" paradigm often are associated with Joe Bain and the Harvard School of IO.[4]

Modern IO recognizes that market structure, the competitive conduct of firms, and the economic performance of the industry are endogenous and jointly determined (shown by Figure 1B). In particular, market structure is determined endogenously through the *entry* decisions of firms, which depend on strategic behavior, entry barriers, and technology. A concentrated market

[3] For discussions of technology standards in the law literature that illustrate these policy conclusions, see Michael G. Cowie & Joseph P. Lavelle, *Patents Covering Industry Standards: The Risks to Enforceability Due to Conduct Before Standard-Setting Organizations*, 30 AIPLA Q.J. 95 (2002); Joseph Kattan, *Antitrust Implications: Disclosures and Commitments to Standard-Setting Organizations*, 16 ANTITRUST 22 (2002); Mark A. Lemley, *Intellectual Property Rights and Standard-Setting Organizations*, 90 CAL. L. REV. 1889 (2002); Janice M. Mueller, *Patent Misuse Through the Capture of Industry Standards*, 17 BERKELEY TECH. L.J. 623 (2002); Gil Ohana, Marc Hansen & Omar Shah, *Disclosure and Negotiation of Licensing Terms Prior to Adoption of Industry Standards: Preventing Another Patent Ambush?*, 24 EUR. COMPETITION L. REV. 644 (2003); *Handbook on the Antitrust Aspects of Standards Setting*, 2004 A.B.A. SEC. ANTITRUST L. chs. 15–17; Mark A. Lemley & Kimberly A. Moore, *Ending Abuse of Patent Continuations*, 84 B.U. L. REV. 63 (2004); M. Sean Royall, *Standard Setting and Exclusionary Conduct: The Role of Antitrust in Policing Unilateral Abuses of Standard-Setting Processes*, 18 ANTITRUST 44 (2004); Robert A. Skitol, *Concerted Buying Power: Its Potential for Addressing the Patent Holdup Problem in Standard Setting*, 72 ANTITRUST L.J. 727 (2005); Carl Shapiro, *Injunctions, Hold-Up, and Patent Royalties*, 12 AM. L. ECON. REV. 280 (2010).

[4] *See* EDWARD H. CHAMBERLIN, THE THEORY OF MONOPOLISTIC COMPETITION (Harvard Univ. Press 8th ed. 1965); EDWARD S. MASON, ECONOMIC CONCENTRATION AND THE MONOPOLY PROBLEM (Holiday House 1964); Joe S. Bain, *Relation of Profit Rate to Industry Concentration: American Manufacturing, 1936–1940*, 65 Q.J. ECON. 293 (1951); JOE S. BAIN, BARRIERS TO NEW COMPETITION: THEIR CHARACTER AND CONSEQUENCES IN MANUFACTURING INDUSTRIES (Harvard Univ. Press 1956); JOE S. BAIN, INDUSTRIAL ORGANIZATION (Chapman & Hall 1959); CARL KAYSEN & DONALD F. TURNER, ANTITRUST POLICY: AN ECONOMIC AND LEGAL ANALYSIS (Harvard Univ. Press 1959); HARVEY J. GOLDSCHMID, HAROLD M. MANN & J. F. WESTON, INDUSTRIAL CONCENTRATION: THE NEW LEARNING (Little Brown 1974); Leonard W. Weiss, *The Structure-Conduct-Performance Paradigm and Antitrust*, 127 U. PA. L. REV. 1104 (1979); Herbert J. Hovenkamp, *United States Competition Policy in Crisis: 1890–1955*, 94 MINN. L. REV. 311 (2009).

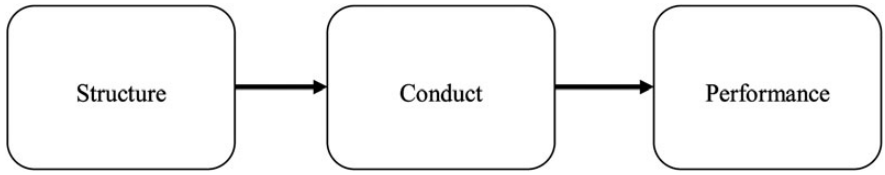

Figure 1. (**A**) Traditional Industrial Organization: the "structure-conduct-performance" paradigm

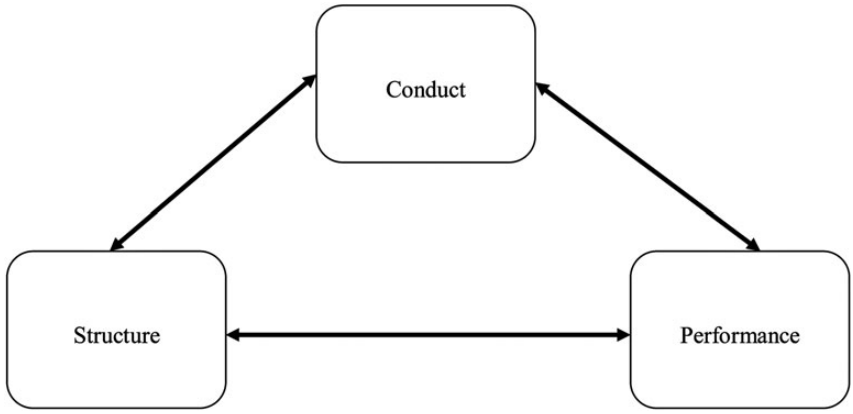

Figure 1. (**B**) Modern Industrial Organization: market structure, competitive conduct, and industry performance are endogenously and jointly determined in equilibrium

structure need not indicate market power. Industries with few firms can be competitive and economically efficient because of strategic interaction among firms and the potential for entry of new firms. Modern IO reflects the contributions of the Chicago School of antitrust.[5] Modern IO also reflects the development of game theoretic approaches to competition and its application to antitrust policy and regulation.[6] Modern IO also benefits from advances in econometric analysis of market equilibria.[7]

[5] *See* GEORGE J. STIGLER, THE ORGANIZATION OF INDUSTRY (Univ. of Chicago Press 1983); RICHARD A. POSNER, ANTITRUST LAW: AN ECONOMIC APPROACH (1st ed. Univ. of Chicago Press 1976); Richard A. Posner, *The Chicago School of Antitrust Analysis*, 127 U. PA. L. REV. 925 (1979); ROBERT H. BORK, THE ANTITRUST PARADOX: A POLICY AT WAR WITH ITSELF (Free Press 1978); Frank H. Easterbrook, *Vertical Arrangements and the Rule of Reason*, 53 ANTITRUST L.J. 135 (1984).

[6] *See* JEAN TIROLE, THE THEORY OF INDUSTRIAL ORGANIZATION (MIT Press 1988), *and* DANIEL F. SPULBER, REGULATION AND MARKETS (MIT Press 1989), for overviews.

[7] *See* Timothy F. Bresnahan & Peter C. Reiss, *Do Entry Conditions Vary Across Markets?*, 18 BROOKINGS PAPERS ON ECON. ACTIVITY 833 (1987); Peter C. Reiss & Pablo T. Spiller, *Competition and Entry in Small Airline Markets*, 32 J.L. & ECON. S179 (1989); Timothy F. Bresnahan & Peter C. Reiss, *Entry in Monopoly Markets*, 57 REV. ECON. STUD. 531 (1990); Timothy F. Bresnahan & Peter C. Reiss, *Entry and Competition in Concentrated Markets*, 99

Traditional IE presumes that technology standards can be considered to be exogenous once they are established; just as traditional IO takes market structure as exogenous once entry has taken place. Then, this paradigm asserts that such exogenous technology standards generate market power for IP owners and thus lead to inefficient innovation. The "Standards-Conduct-Performance" paradigm asserts that technology standards determine the competitive conduct of IP owners, which, in turn, determines the economic performance of technology and product markets (shown by Figure 2A). The "Standards-Conduct-Performance" paradigm is developed extensively in the economics and legal literatures.

Modern IE, in contrast, understands that technology standards are endogenous, just as market structure is endogenous. The competitive conduct of firms and the economic performance of innovative industries affect the choice of technology standards (shown by Figure 2B). Technology standards adjust to market competition and industry coordination through standards organizations. The design of technology standards and negotiation of commercialization agreements reflect the extent of competition among inventors and among producers that use inventions and the level of economic performance in markets for inventions and final products. The returns to innovations that satisfy technology standards provide incentives for additional innovation and for the development of additional technology standards. Because technological standards are equilibrium outcomes, not exogenous forces, they reflect the strategic interaction and ongoing innovative efforts of market participants.

In this article, I examine the interplay among technology standards, competitive conduct, and innovative efficiency. I define *innovative efficiency* as productivity in knowledge creation, application, and commercialization for an industry or a group of industries. Industry-level measures of innovative efficiency differ from firm-level measures of productivity of research and development (R&D) investment.[8] I suggest that understanding equilibrium technology standards, competitive strategies, and innovative efficiency requires the application of game theoretic analysis. Empirical analysis consistent with

J. Pol. Econ. 977 (1991); Steven T. Berry, *Estimation of a Model of Entry in the Airline Industry*, 60 Econometrica 889 (1992). *See also* Richard Schmalensee, *Inter-Industry Studies of Structure and Performance*, *in* 2 Handbook of Industrial Organization 951 (Richard Schmalensee & Robert D. Willig eds., Elsevier 1989); John Sutton, Sunk Costs and Market Structure: Price Competition, Advertising, and the Evolution of Concentration (MIT Press 1991); Liran Einav & Jonathan D. Levin, *Empirical Industrial Organization: A Progress Report*, 24 J. Econ. Persp. 145 (2010).

[8] Firm-level analyses include measures of R&D output based on patents and patent citations. *See, e.g.*, Zvi Griliches, *Patent Statistics as Economic Indicators: A Survey*, 28 J. Econ. Lit. 1661 (1990); David Hirshleifer, Po-Hsuan Hsu & Dongmei Li, *Innovative Efficiency and Stock Returns*, 107 J. Fin. Econ. 632 (2013).

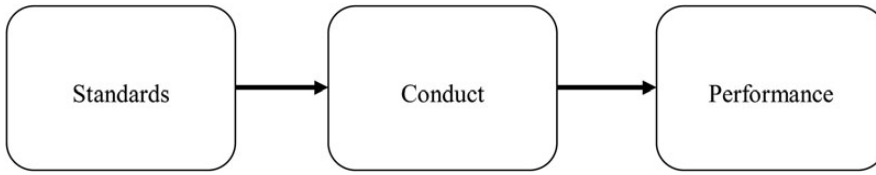

Figure 2. (**A**) Traditional Innovation Economics: the "Standards-Conduct-Performance" paradigm

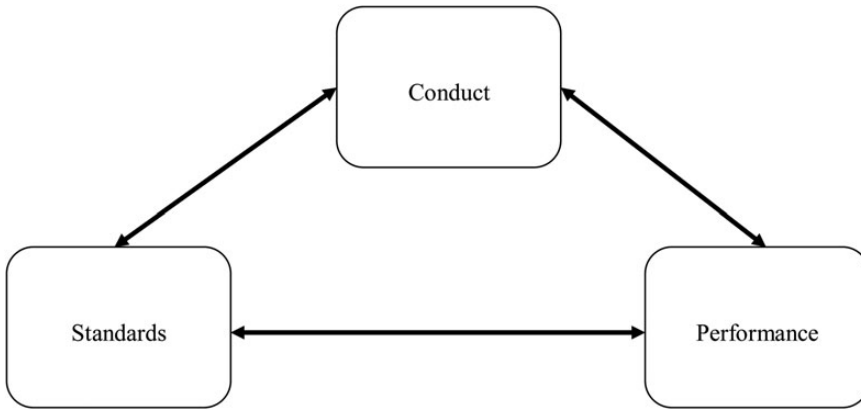

Figure 2. (**B**) Modern Innovation Economics: technology standards, competitive conduct, and economic performance (innovative efficiency) are ndogenously and jointly determined in equilibrium

modern IE requires combining economic analysis of competition and innovation with statistical models to avoid results subject to endogeneity bias.[9]

I reach the following conclusions. I find that *industries with dominant technological standards can be highly competitive and innovative*. Technology standards provide incentives for increased competition and innovation and improve innovative efficiency. Technology standards are endogenous because they are the result of market competition and industry cooperation through standards organizations. Standards organizations revise or replace technology standards in response to innovation, and there is competition among standards organizations, and between technologies within and across standards.

I further emphasize that patents are fundamental to the formation of markets for inventions. When there are markets for inventions, competition among inventors and among producers increase incentives to invent and to

[9] The combination of economic theory with statistical models is sometimes referred to as structural econometric modeling. *See* Peter C. Reiss & Frank A. Wolak, *Structural Econometric Modeling: Rationales and Examples from Industrial Organization*, *in* 6A HANDBOOK OF ECONOMETRICS 4277 (James J. Heckman & Edward E. Leamer eds., Elsevier 2007).

innovate.[10] I find that patents themselves do not confer market power on their owners because of actual and potential competition from innovative substitutes and complements. Innovative substitutes (complements) refer to inventions that are economic substitutes (complements) in the production of innovations. I conclude that SEPs need not confer market power on their owners because technology standards and competition are endogenous and jointly determined.

The modern IE approach suggests that public policy recommendations based on the "Standards-Conduct-Performance" paradigm are subject to conceptual errors. The traditional view has led to a proliferation of unsupported concerns that technology standards have detrimental economic effects on competition and innovation.[11] I suggest that there is little economic foundation for concerns about (1) "patent holdup" and "standards holdup," (2) "technology lock-in," (3) "royalty stacking," and (4) "patent thickets." I reject the traditional IE view that SEPs "necessarily" confer market power on patent owners. I further reject traditional IE arguments that technology standards and IP can be used by incumbent firms to foreclose entry of competitors.[12] In addition, I show that the traditional IE argument that technology standards determine market competition and innovation ignores the dynamic nature of standard-setting processes and the dynamic interaction between competition, innovation, and technology standards.

The discussion is organized as follows. Part II examines the relationships among technology standards, competitive conduct, and innovative efficiency. Part III considers the relationship between patents and market power when inventions are innovative substitutes. Part IV considers the relationship between patents and market power when inventions are innovative complements. Part V concludes the discussion by highlighting some implications of the endogeneity of technology standards for antitrust policy.

[10] *See* Daniel F. Spulber, *Competing Inventors and the Incentive to Invent*, 22 INDUS. CORP. CHANGE 33 (2013); Daniel F. Spulber, *How Do Competitive Pressures Affect Incentives to Innovate When There Is a Market for Inventions?*, 122 J. POL. ECON. (forthcoming 2014).

[11] *See, e.g.*, FED. TRADE COMM'N, THE EVOLVING IP MARKETPLACE: ALIGNING PATENT NOTICE AND REMEDIES WITH COMPETITION 22 (2011) [hereinafter FTC REPORT]. The FTC recommends antitrust scrutiny of patent owners and standards organizations, suggesting that "[c]ourts should cap the royalty at the incremental value of the patented technology over alternatives available at the time the standard was chosen." For an analysis of these arguments, see Richard A. Epstein, F. Scott Kieff & Daniel F. Spulber, *The FTC, IP, and SSOs: Government Hold-Up Replacing Private Coordination*, 8 J. COMPETITION L. & ECON. 1 (2012).

[12] The foreclosure argument is also associated with traditional Industrial Organization. *See, e.g.*, Herbert Hovenkamp, *Harvard, Chicago, and Transaction Cost Economics in Antitrust Analysis*, 55 ANTITRUST BULL. 613 (2010) ("The leverage theory itself never dominated Harvard industrial organization theory or competition policy. Rather the concern was foreclosure, or the idea that firms could use pricing, vertical restrictions or intellectual property (IP) licensing practices to exclude rivals from otherwise profitable markets.").

II. TECHNOLOGY STANDARDS AND COMPETITION

Technology standards should not be viewed as causing market power for owners of SEPs. This is because technology standards and competitive conduct are endogenous and jointly determined, whether technology standards are established by market competition, industry organizations, or government regulation. The joint determination of technology standards and competitive conduct implies that one cannot draw causal inferences from technology standards to competitive conduct. Different types of competitive conduct of inventors and producers and different types of cooperative interaction among inventors and producers will affect technology standards. This part introduces a general approach to the endogenous and joint determination of technology standards, competitive conduct, and economic efficiency. The approach emphasizes that antitrust and innovation policy must take into account these complex interactions.

A. Technology Standards and Market Power

Rather than being exclusive, technology standards are inclusive of competitors and thus generally serve to promote entry and competition. Therefore, technology standards reduce market power by fostering entry of innovative substitutes and complements. Antitrust policy makers have recognized that technology standards are endogenous and that technologies compete to be included in standards. The Federal Trade Commission (FTC) for example states that in information technology (IT) "firms often achieve interoperability among products by working together in standard-setting organizations (SSOs) to jointly adopt industry-wide technical standards. Alternative technologies compete for inclusion in the standard."[13]

The modern IE approach as presented here offers a dynamic framework that takes into account strategic behavior in the formation of technology standards and the feedback effects of competitive conduct. This involves the application of game theory in economic models of technology standard formation, whether standards are established through cooperation in standards organizations or through market competition. Because of feedback effects, it is not possible to use observations of technology standards to predict competitive conduct in the marketplace. Different types of competitive conduct by inventors and producers will generate different types of technology standards. Economic analysis of competition and innovation should provide guidance for empirical reduced-form and structural models and help form the basis for public policy making and legal decisions.

Technology standards cannot be viewed as exogenous determinants of competitive conduct and economic performance. Rather, there is interaction

[13] FTC REPORT, *supra* note 11, at 22.

between technological standard setting and competitive conduct of market participants. Competitive strategies and competitive interaction among market participants will affect technology standards. Competition among inventors, competition among producers that use inventions, and coordination among inventors and producers will affect the development of technology standards. Also, technology standards will affect competitive interaction and coordination among industry participants, with important standards attracting entry and innovation.

Technology standards are endogenous to the economy because they are established by three types of coordination mechanisms: market competition, standards organization, and government regulation.[14] First, market participants establish technology standards through a mixture of cooperation and competition. Inventors develop and commercialize new technologies, firms make investments in applying inventions and offering new products and services, inventors and firms enter into contractual agreements that implement particular technology standards, and buyers choose among competing products offered by firms. Competition among inventors in markets for inventions and competition among producers in product markets establish many types of technology standards.

Often, standards organizations follow market standards. Innovation and market competition determine the value of patents, not standards organizations. Consider, for example, competition among multiple television operating system platforms. There are many competing technologies for the delivery of Internet access, music, games, and streaming video.[15] Technology standards for Internet TV will reflect competition among producers, the quality and prices of alternative products, the quality of competing technologies, and the availability of content.

[14] Joseph Farrell and Garth Saloner introduce a game theoretic analysis of standard setting suggesting that a combination of market interaction and standard-setting organizations generates better outcomes than only one type of institution. Joseph Farrell & Garth Saloner, *Coordination Through Committees and Markets*, 19 RAND J. ECON. 235 (1988). *See also* Joseph Farrell & Tim Simcoe, *Choosing the Rules for Consensus Standardization*, 43 RAND J. ECON. 235 (2012); Gastón Llanes & Joaquín Poblete, *Ex-Ante Agreements in Standard Setting and Patent-Pool Formation*, 23 J. ECON. & MGMT. STRATEGY (forthcoming 2014).

[15] Among the many operating system platforms are Google TV (along with Sony and LG Electronics), Sony Bravia TV (including the Sony Entertainment Network and the Playstation game platform), Samsung Smart TV, Panasonic's Viera system, LG Electronic NetCast Entertainment Access, Microsoft Xbox 360, and Vizio Smart TVs. In addition, there is the Smart TV Alliance involving Toshiba, LG Electronics, Philips, and Panasonic. According to Hyun-suk Kim, the head of Samsung's TV business, "[a]lliances may be possible but we're not at that stage yet. . . . Everybody is using their own platform right now, but the small companies find it very difficult to get content and services. Having a unified platform would be very helpful for the industry but I'm not sure it's the right time" for Samsung. *See* Cornelius Rahn & Jonathan Browning, *TV Makers Join Forces Against Smartphone Giants*, N.Y. TIMES (Sept. 5, 2012), http://www.nytimes.com/2012/09/06/technology/06iht-srtvs06.html?_r=0.

Market competition is a dynamic process with interaction between innovation and the formation of standards. Competing companies choose whether or not to make their products compatible. Consumer demand affects the success of products and the technological features of those products. Customer needs create incentives for innovation to meet those needs. Technological innovation provides means to meet customer needs and generates technological change. Market competition and coordination among buyers and sellers foster technological change and prevent "lock-in."[16]

Second, industry participants form standards organizations that are themselves endogenous, and these organizations establish technology standards through negotiations and agreements among their members. The selection of standards by these organizations is not an "arbitrary" choice but generally is based on quality of technological performance.[17] Standards organizations are private ordering mechanisms that help industry participants address coordination costs and network effects, thus preventing inefficient "lock-in."[18]

Firms decide to join standard-setting organizations based on various economic incentives. Although participation can be costly, standards organizations help to lower the transaction costs associated with coordination of technology choices among inventors and producers. Standards organizations provide a means for inventors and producers to exchange information about R&D and product designs. Standards organizations help to identify promising technologies and to provide information to industry participants.[19] Talia Bar and Aija Leiponen find that SSOs foster information exchange and help companies access complementary R&D assets through firms' social networks.[20]

[16] *See* Daniel F. Spulber, *Unlocking Technology: Antitrust and Innovation*, 4 J. COMPETITION L. & ECON. 915 (2008). On the question of technology standardization, see also James A. Brander & Jonathan Eaton, *Product Line Rivalry*, 74 AM. ECON. REV. 323 (1984); Michael L. Katz & Carl Shapiro, *Network Externalities, Competition, and Compatibility*, 75 AM. ECON. REV. 424 (1985); Joseph Farrell & Garth Saloner, *Installed Base and Compatibility: Innovation, Product Preannouncement, and Predation*, 76 AM. ECON. REV. 940 (1986); Michael L. Katz & Carl Shapiro, *Technology Adoption in the Presence of Network Externalities*, 94 J. POL. ECON. 822 (1986); Joseph Farrell & Garth Saloner, *Standardization, Compatibility, and Innovation*, 16 RAND J. ECON. 70 (1985); Carmen Matutes & Pierre Regibeau, *"Mix and Match": Product Compatibility Without Network Externalities*, 19 RAND J. ECON. 221 (1988).

[17] Recall that Farrell, Hayes, Shapiro, and Sullivan argue that "[i]n the extreme, a standard could be built around initially arbitrary choices that become essential once the standard is established." Farrell, Hayes, Shapiro & Sullivan, *supra* note 1, at 607–08.

[18] *See* Spulber, *Unlocking Technology*, *supra* note 16.

[19] *See* Mark Rysman & Tim Simcoe, *Patents and the Performance of Voluntary Standard Setting Organizations*, 54 MGMT. SCI. 1920 (2008). Rysman and Simcoe explicitly address the causality problem: "do SSOs' efforts to promote industry coordination confer an advantage on the standards they promote, or do these groups merely identify or attract important technologies?" *Id.* at 1932. Based on patent citations, they find "substantial evidence that SSOs identify and endorse important technologies," thus suggesting that SSOs need not confer an advantage on owners of SEPs. *Id.* at 1932.

[20] Talia Bar & Aija E. Leiponen, *Committee Composition and Networking in Standard Setting: The Case of Wireless Telecommunications*, 23 J. ECON. & MGMT. STRATEGY (forthcoming 2014).

Justus Baron and Tim Pohlmann find that industry consortia provide a means of reducing the costs of developing technology standards by reducing R&D duplication and by resolving disagreements before formal standards setting occurs.[21] Also, patent owners can make general pricing commitments though participation in standards organizations with fair, reasonable, and nondiscriminatory (FRAND) pricing rules. Antitrust policies and regulations that impose general constraints on royalties could discourage participation in standard setting.[22]

Standards organizations cannot be said to serve the interests of particular patent owners. Multiple patent owners compete within SSOs to have their inventions included in the standard, so that the standard is not driven by considerations of potential market power for an individual patent owner. In addition, companies working on technologies participate in SSOs and would not agree to standards that would inefficiently constrain their ability to contribute innovative substitutes. Producers also participate in the standard-setting process so again the standard is not based on returns to patent owners. David Teece and Edward Sherry argue that producers have greater bargaining power in SSOs due to their common interests in contrast to the diffuse competing interests of individual inventors.[23] This suggests that technology standards would tend to favor producers rather than IP owners. In addition, bilateral bargaining between producers and technology owners accompanies the standard-setting process, further limiting the returns to IP. Inventors and producers are likely to recognize that there are tradeoffs between competition and the quality of the technologies included in the standard. Competition across standards and among standards organizations provides incentives to emphasize the quality of the technology.

Finally, governments establish particular technology standards through legislation and regulation. Many of these standards are endogenous because they are the result of public choice mechanisms, including voting, lobbying, and regulatory bargaining. Regulatory bargaining in the United States is subject to due process and other administrative rules that reflect the competing interests of industry participants.[24] Government regulatory agencies often adopt "de facto" industry standards established through market competition

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Leiponen finds that firms that participate in industry consortia may exercise greater influence within standards organizations. Aija Elina Leiponen, *Competing Through Cooperation: The Organization of Standard Setting in Wireless Telecommunications*, 54 MGMT. SCI. 1904 (2008).

[21] Justus Baron & Tim Pohlmann, *Who Cooperates in Standards Consortia—Rivals or Complementors?*, 9 J. COMPETITION L. & ECON. 905 (2013).

[22] *See* Anne Layne-Farrar, Gerard Llobet & Jorge Padilla, *Payments and Participation: The Incentives to Join Cooperative Standard Setting Efforts*, 23 J. ECON. & MGMT. STRATEGY (forthcoming 2014).

[23] David J. Teece & Edward F. Sherry, *Standards Setting and Antitrust*, 87 MINN. L. REV. 1913 (2003).

[24] SPULBER, REGULATION AND MARKETS, *supra* note 6.

and industry cooperation, as occurred for regulations governing product quality and safety and workplace health and safety.[25]

Government standards are not new, with commercial standards dating back to the Magna Carta: "There is to be a single measure for wine throughout our realm, and a single measure for ale, and a single measure for Corn, that is to say the London quarter, and a single breadth for dyed cloth, russets, and haberjects, that is to say two yards within the lists. And it shall be the same for weights as for measures."[26] Government mandated standards tend to be coercive in comparison to voluntary private standards.[27] Government standards often are less efficient than those established through market competition and standards organizations, particularly when policy makers favor incumbent producers due to grandfathering and regulatory entry barriers. The solution to inefficiencies generated by government regulatory standards is for public policy makers to set general rules rather than detailed technological specifications.[28] Market competition and industry standards organizations provide better mechanisms for establishing detailed technological standards.

B. Technology Standards, Modularity, and SEPs

Technology standards do not confer market power on owners of SEPs. To the contrary, the process of choosing technology standards tends to promote innovation that generates actual and potential competition among owners of SEPs. Technology standards promote entry of innovative substitutes that satisfy the standard, limiting the market power (if any) of SEP owners. Technology standards also promote the entry of innovative complements that generate actual and potential competition among owners of SEPs.[29] Competition among innovative complements also limits the market power of owners of SEPs. As Nirvikar Singh and Xavier Vives observe with reference to competition among product suppliers, "Cournot (Bertrand) competition

[25] *Id.*

[26] *Magna Carta Translation*, NAT'L ARCHIVES & RECORDS ADMIN. (Nicholas Vincent trans., copy. Sotheby's Inc. 2007), http://www.archives.gov/exhibits/featured_documents/magna_carta/translation.html.

[27] Teece & Sherry, *supra* note 23.

[28] *See* FRIEDRICH A. HAYEK, THE CONSTITUTION OF LIBERTY 220–21 (Univ. of Chicago Press 1960). *See also* SPULBER, REGULATION AND MARKETS, *supra* note 6.

[29] Competition for downstream rents among suppliers of complements was first noted by AUGUSTIN COURNOT, RESEARCHES INTO THE MATHEMATICAL PRINCIPLES OF THE THEORY OF WEALTH (Nathaniel Bacon trans., Macmillan 1927) (1838). For additional studies of competition among suppliers of complements, see Nirvikar Singh & Xavier Vives, *Price and Quantity Competition in a Differentiated Duopoly*, 15 RAND J. ECON. 546 (1984); Carmen Matutes & Pierre Regibeau, *Mix and Match: Product Compatibility Without Network Externalities*, 19 RAND J. ECON. 221 (1988); Carmen Matutes & Pierre Regibeau, *Compatibility and Bundling of Complementary Goods in a Duopoly*, 40 J. INDUS. ECON. 37 (1992); Nicholas Economides & Steven C. Salop, *Competition and Integration Among Complements, and Network Market Structure*, 40 J. INDUS. ECON. 105 (1992).

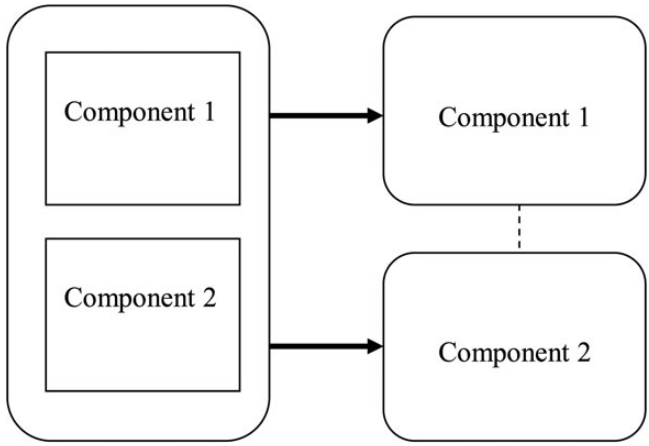

Figure 3. Modularization of interconnected systems to form a technology platform with separable components
Note: The dashed line is the module boundary where interoperability is required.

with substitutes is the dual of Bertrand (Cournot) competition with complements."[30]

Technology standards provide important economic benefits because they are necessary for the modularity of complex technological systems. *Modularity* refers to technology platforms with separable components, in contrast to interconnected technological systems. This is illustrated in Figure 3. Modularity generates economic benefits for firms because they can divide manufacturing and innovative efforts to focus on the components of the platform.[31] Modularity of advanced technological systems allows firms to update products, manufacturing processes, and business methods to take advantage of technological progress in components of complex systems without the need to change the entire system.

Modularity generates similar economic benefits for industries and for the economy as a whole. These economic benefits stem from the classic forces of specialization and division of labor first identified by Adam Smith in *The Wealth of Nations.* Industries benefit from specialization and division of labor in both manufacturing and innovation. Industries and the economy benefit from technological progress in components of complex systems. For example, given a particular computer platform, the performance of the system as a whole can be improved by innovations in particular components such as microprocessors, memory, operating systems software, applications software,

[30] Singh & Vives, *supra* note 29, at 553.
[31] *See* Carliss Y. Baldwin & Kim B. Clark, Design Rules: The Power of Modularity (MIT Press 2000); Andrea Gamba & Nicola Fusari, *Valuing Modularity as a Real Option*, 55 Mgmt. Sci. 1877 (2009).

and peripheral hardware. Producers and customers can customize platforms by choosing optimal combinations and configurations of components based on prices and performance.[32]

Modularity requires technological compatibility and interoperability among modules, particularly at the boundaries of modules.[33] A firm that produces platforms with modular components must coordinate its internal production and innovative activities to achieve interoperability. When an industry or a group of industries participates in the development and usage of a technology platform with modularity, it is necessary for market transactions and cooperative agreements to provide coordination among market participants.[34] Standards organizations provide mechanisms for inventors and producers to form cooperative agreements that ensure interoperability.

Standards organizations allow industries to obtain the benefits of modularity by creating technological specifications that identify performance targets for components and generate interoperability among components. *Performance targets* are quality standards that are useful for coordination among market participants. *Interoperability standards* allow industry participants to achieve compatibility and connectivity of components that form technological systems. This in turn promotes competition among providers of those components that conform to the technology standards. The result is an increase in competition among innovative substitutes and complements.

Many types of technology standards promote interoperability particularly in the Information and Communications Technologies (ICT) industries. For example, the European Telecommunications Standards Institute (ETSI) produces international standards for ICT.[35] According to ETSI, "The main aim of standardization is to enable interoperability in a multi-vendor, multi-network, multi-service environment."[36] The Institute of Electrical and Electronics Engineers (IEEE) states that: technology standards "form the fundamental building blocks for product development by establishing consistent protocols that can be universally understood and adopted. This helps fuel compatibility and interoperability and simplifies product development, and speeds time-to-market."[37]

[32] When firms' competencies differ, component competition may be more efficient than systems competition. *See* Joseph Farrell, Hunter K. Monroe & Garth Saloner, *The Vertical Organization of Industry: Systems Competition Versus Component Competition*, 7 J. ECON. & MGMT. STRATEGY 143 (1998).

[33] *See* Carliss Y. Baldwin, *Where Do Transactions Come From? Modularity, Transactions, and the Boundaries of Firms*, 17 INDUS. & CORP. CHANGE 155 (2007); Rebecca M. Henderson & Kim B. Clark, *Generational Innovation: The Reconfiguration of Existing Systems and the Failure of Established Firms*, 35 ADMIN. SCI. Q. 9 (1990).

[34] *See supra* note 33.

[35] *About ETSI*, ETSI, http://www.etsi.org/about.

[36] *Interoperability*, ETSI, http://www.etsi.org/standards/interoperability.

[37] *What Are Standards?*, IEEE STANDARDS ASS'N, http://standards.ieee.org/develop/overview.html.

C. The Industrial Organization of Standards Organizations

Technology standards do not confer market power on owners of SEPs because there can be multiple innovative substitutes that satisfy a given standard and are still labeled as patents that are "essential" to the standard. In addition, there will generally be multiple innovative complements that form the modules within a technological system.

Competition by IP owners within a technology standard limits their market power.[38] In addition, if IP owners within a technology standard do achieve some market power based on the quality of their technology, this helps to create incentives for the development and entry of additional inventions that conform to the standard. Moreover, the possibility that owners of particular patents might have market power because of the value of their technology affects the development of a standard. Competing inventors and producers who use the technology will set standards to promote competition and additional innovation. Standards that encourage competition and additional innovation will be more successful than those that do not because participation by inventors and producers is voluntary.

Technology standards generally do not cause vertical exclusion of patent owners who provide innovative substitutes and complements. Instead, technology standards tend to facilitate entry of providers of innovative substitutes and complements. One reason that the SEP terminology can be confusing or misleading is that it might appear to refer to the antitrust doctrine of "essential facilities." The concept of "essential facilities" denotes facilities that are necessary for access to a particular market but whose duplication requires extremely high levels of investment, thus preventing entry. There is nothing inherent in a technology standard that prevents investment in R&D by inventors to develop new substitute inventions that satisfy the standards. Therefore, the analogy to "essential facilities" doctrine is flawed and cannot be used as a guide to policy. In addition, the "essential facilities" doctrine itself does not guide antitrust policy because it is not recognized by the Supreme Court.[39] There is little economic or legal basis for reviving the "essential facilities" doctrine in the context of patents.

The SEP terminology is confusing or misleading in another way—many SEPs are neither necessary nor relevant to the standard. The patent owner usually determines whether or not their patent is classified as being "essential" to a standard. Often, many patents are SEPs for a particular standard because firms declare their patents as "essential" to avoid later legal penalties for

[38] Teece & Sherry, *supra* note 23.

[39] Verizon Commc'ns Inc. v. Law Offices of Curtis V. Trinko, LLP, 540 U.S. 398, 411 (2004). *See also* Daniel F. Spulber & Christopher S. Yoo, *Mandating Access to Telecom and the Internet: The Hidden Side of Trinko*, 107 COLUM. L. REV. 1822 (2007).

nondisclosure.[40] Firms may have an incentive to list large numbers of their patents as being "essential" for administrative convenience or to keep open the option of licensing the technology individually or as part of a portfolio, even if those patents are not necessary to achieve the standard.[41] David Goodman and Robert Myers consider 7,796 patents and patent applications declared essential to two third-generation cellular technologies: wideband code division multiple access (WCDMA) and CDMA2000. They find that "nearly 80% of the patents declared essential are probably not essential for practicing the standards under the narrow definition of essential adopted by the standards organizations."[42]

As a result, many so-called SEPs need not be licensed by producers that offer products conforming to a particular standard. Furthermore, technology standards will include multiple competing innovative substitutes and complements so that producers may choose among various patented or public domain technologies that satisfy a particular standard. Put differently, SEPs need not be innovative complements. When substitute inventions satisfy a technology standard, competition limits the market power of inventors supplying technologies. Successful SSOs will create incentives for additional innovation and entry of inventors and producers.

Even if owners of particular SEPs do have market power due to the quality of their technologies, their market returns will be limited rather than enhanced by technology standards. The reason that technology standards will tend to limit the returns of owners of SEPs has to do with the Industrial Organization of standard setting itself. Just as the entry of firms determines market structure in various industries, there is "entry" in the formation of standards organizations by industry participants. There is significant competition among SSOs that serves to mitigate the market power of those organizations and limits the market effects of the technology standards that they establish. Benjamin Chiao, Josh Lerner, and Jean Tirole find that "the density of SSOs is quite high. The mean SSO has 13.9 other SSOs in its subfield (with a median of 13.5)."[43] Even if a patent were "essential" for a standard and did not face

[40] *See* Anne Layne-Farrar, A. Jorge Padilla & Richard Schmalensee, *Pricing Patents for Licensing in Standard-Setting Organizations: Making Sense of FRAND Commitments*, 74 ANTITRUST L.J. 671, 678 (2007) ("the list of disclosed 'essential' patents for a given standard is likely to be a mixture of the patents that firms can readily identify, those that firms are not too reluctant to disclose for valid strategic reasons, and those that may or may not be genuinely essential for implementation but are included as insurance against the threat of non-disclosure litigation.").

[41] This incentive may be tempered by the SSO's FRAND restrictions on royalties for patents that are declared to be essential to a standard.

[42] David J. Goodman & Robert A. Myers, *3G Cellular Standards and Patents*, *in* 1 2005 INTERNATIONAL CONFERENCE ON WIRELESS NETWORKS, COMMUNICATIONS AND MOBILE COMPUTING 415 (Inst. Electrical & Electronic Eng'rs, Inc. 2005).

[43] Benjamin Chiao, Josh Lerner & Jean Tirole, *The Rules of Standard Setting Organizations: An Empirical Analysis*, 38 RAND J. ECON. 905, 925 (2007).

competition within that standard, competition among standards and among standards organizations would limit any market power of the owner of that patent.

IO theory suggests that if standards organizations were to create standards that generated economic rents, then this would create incentives for the entry of additional standards organizations offering competing technology standards. The entry of SSOs and their technology standards, membership and rules are endogenous and jointly determined with competitive conduct among SSOs. IP owners compete *across* technology standards because products satisfying different standards can compete and there is "entry" of new technologies across standards. For example, LTE competes with WiMAX in mobile networks: "the whole cell phone industry turned away from WiMAX (and Intel) to LTE, which came from the same folks who brought us GSM and promised much better compatibility with existing cell phone equipment."[44]

Even if the number of standards organizations were to remain fixed, there is "entry" of new technology standards that compete with each other. Standards organizations revise existing technology standards and establish new standards that include new technologies. Technologies that meet new standards compete with technologies covered by existing standards. Patents that read on a particular standard may no longer apply to the revised standard or may face additional competition under the revised standard. IP owners compete over time as new technologies emerge and technology standards change so that the before-and-after distinction used by policy makers has limited practical application.

D. Dynamics of Innovation and Standard Setting Versus the *Ex Ante-Ex Post* Fallacy

The proliferation of standards is an indication of technological change rather than being a source of inertia.[45] Even without the development of new standards and without the entry of new standards organizations, new technologies can "enter" the market as inventors continue to develop and patent new inventions that meet an existing standard. When owners of SEPs earn economic rents, there are greater incentives for inventors to develop new inventions that satisfy the standard. This means that the number of innovative substitutes that

[44] Sascha Segan, *WiMAX vs. LTE: Should You Switch?*, PCMAG.COM (May 16, 2012), http://www.pcmag.com/article2/0,2817,2403490,00.asp.

[45] *See* Justus Baron & Julia Schmidt, *Technological Standardization, Endogenous Productivity and Transitory Dynamics* 2 (Working Paper May 2013), *available at* http://www.law.northwestern.edu/faculty/programs/searlecenter/innovationeconomics/documents/Technological_Standardization_Endogenous_Productivity_and_Transitory_Dynamics.pdf (as indicators of technological change, "standards are economically and technologically highly meaningful, because they reflect the actual adoption (instead of invention) of an innovation and *trigger* technological diffusion." (emphasis in original)).

address a technology standard should not be taken as given and cannot be inferred from the characteristics of the technology standard.

Standards generally do not preclude entry of competing innovative substitutes and often facilitate such entry. Teece and Sherry point out that "[m]any standards (including many interoperability standards) do not specify a 'design for a product' so much as they identify certain *features* of the product that are standardized, leaving many if not most other product features unspecified and unstandardized."[46] Whether particular inventions are complements or substitutes can change over time in response to price changes or changes in the functionalities of the final product.[47]

The traditional IE approach based on the "Standards-Conduct-Performance" paradigm maintains that technology standards confer market power on owners of SEPs. The U.S. Department of Justice (DOJ) and the FTC express the traditional view:

> Before, or *ex ante*, multiple technologies may compete to be incorporated into the standard under consideration. Afterwards, or *ex post*, the chosen technology may lack effective substitutes precisely because the SSO chose it as the standard. Thus, *ex post*, the owner of a patented technology necessary to implement the standard may have the power to extract higher royalties or other licensing terms that reflect the absence of competitive alternatives. Consumers of the products using the standard would be harmed if those higher royalties were passed on in the form of higher prices.[48]

This approach does not take into account the entry of new inventions and innovations after standards are developed. In addition, the standard may encourage rather than discourage additional entry.

The *ex ante-ex post* distinction misrepresents the complex interactions between standards and innovation. Standard setting involves multiple iterations in standards development and repeated interaction among participants. Standard setting is a dynamic process that generally involves multiple revisions of the standards. As the IEEE points out "It is important to remember that standards are 'living documents,' which may initially be published and iteratively modified, corrected, adjusted and/or updated based on market conditions and other factors."[49]

[46] Teece & Sherry, *supra* note 23, at 1914 (emphasis in original).

[47] Josh Lerner & Jean Tirole, *Public Policy Toward Patent Pools*, *in* 8 INNOVATION POLICY AND THE ECONOMY 157 (Adam B. Jaffe, Josh Lerner & Scott Stern eds., Nat'l Bureau of Econ. Research 2008).

[48] U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, ANTITRUST ENFORCEMENT AND INTELLECTUAL PROPERTY RIGHTS: PROMOTING INNOVATION AND COMPETITION 35–36 (2007) (internal citations omitted), *available at* www.justice.gov/atr/public/hearings/ip/chapter_2.pdf [hereinafter FTC ANTITRUST GUIDELINES].

[49] *How Are Standards Made?*, IEE STANDARDS ASS'N, http://standards.ieee.org/develop/process.html.

The standard-setting process is also dynamic because it interacts with continual technological change. As Joe Bhatia, CEO of American National Standards Institute (ANSI), points out,

> [i]n some cases, a standard will precede innovation by establishing a baseline for design and performance that will satisfy user requirements. Other times, an innovative idea that finds its place in the market becomes the foundation of a new standard, which then becomes the physical documentation of an agreed-upon solution that has already been time-tested and proven.[50]

Even if standards reflect existing innovations, the standard is an organizational consensus based on market outcomes. Standards generally do not specify a particular technology after the fact but instead often stimulate future rounds of technological innovation.

In practice, technology standards provide incentives for inventors and manufacturers to innovate "on top" of the standard. Inventors develop new technologies that satisfy standards and manufacturers enhance the standardized features of products. In turn, these improvements in existing technologies and development of new technologies influence further refinement and development of technology standards. Also, market entry and participation in standards organizations can change significantly over time in response to market adoption of a standard. The widespread adoption of wireless cellular standards was accompanied by entry and exit of inventors and manufacturers.

Thus, neither the existence of a standard nor inclusion of patents in a standard allows inference of market power by patent holders. Standards and inclusion of patents in a standard do not imply harm to consumers. Rather, the existence of a standard is part of an ongoing process of innovation, technological change, standardization, and changes in standards. Standards do not indicate the absence of effective substitutes because the standards themselves change, current technologies compete with each other, and current technologies face competition from future technologies.

The incorrect *ex ante-ex post* distinction is similar to the traditional IO view of market structure. In the traditional IO view, before entry, or *ex ante*, multiple firms compete to enter a market thereby establishing market structure, and after entry, or *ex post*, that market structure determines competitive conduct and economic performance. Because of this *ex ante-ex post* framework, traditional IO asserted that a concentrated market structure implies that firms have market power. Modern IO shows that this view of market formation is incorrect because market structure and competitive

[50] Letter from S. J. Bhatia, President and CEO, American National Standards Institute (ANSI), to Congressman Bart Gordon, Chairman, House Committee on Science and Technology (Nov. 12, 2009), *available at* http://publicaa.ansi.org/sites/apdl/Documents/Standards%20Activities/Critical%20Issues/Gordon%20Inquiry/Gordon_ANSI_response.pdf.

conduct are endogenous and jointly determined. For example, the number of firms that enter a market will differ depending on whether firms engage in Cournot quantity competition or Bertrand price competition so that competitive conduct has feedback effects on market structure. Therefore, it is not possible to infer market power from industry concentration; a small number of firms in the market may compete intensively and may also face competition from potential entry.

E. The "Patent Holdup" and "Standards Holdup" Fallacies

The traditional IE approach suggests that patent owners have market power by extending the artificial *ex ante-ex post* distinction. This artificial distinction underlies the policy concern that patent owners can profit from "patent holdup" and "standards holdup." For example, the FTC argues that:

> Once a technology is incorporated into a standard, a firm with a patent reading on the technology can demand a royalty that reflects not only the value of the technology compared to alternatives, but also the value associated with investments made to implement the standard. Switching costs may be prohibitively high when an industry becomes locked into using standardized technology. Were patentees able to obtain the hold-up value, this overcompensation could raise prices for consumers while undermining efficient choices made among technologies competing for inclusion in a standard.[51]

This argument supposes that standards cause industries to be "locked in" to technology choices making them subject to "holdup" by owners of SEPs.

1. Traditional IE and the "Patent Holdup" Fallacy

The "patent holdup" argument maintains that patent owners have market power because infringers are unaware of a patent and face costs of switching to a new technology. The patent owner is alleged to take advantage of the switching costs of infringing licensees by increasing royalties in license negotiations. These arguments are based on flawed conceptions of markets for IP that ignore mechanisms for coordination and the formation of contractual agreements between inventors and manufacturers.

The notion of "holdup" in economics is based on a set of very specific assumptions. First, it is assumed that a buyer and a seller cannot negotiate a binding agreement or contract. Second, it is assumed that a buyer and a seller somehow become "locked" in a relationship, what Oliver Williamson calls the "fundamental transformation," with limited outside options. Third, it is assumed that a buyer and a seller make irreversible "transaction-specific" investments that are not applicable in pursuing outside options. The combination of these assumptions implies that the parties negotiate the terms of their agreement only after making investments so that a "holdup" occurs. The terms of exchange

[51] FTC REPORT, *supra* note 11, at 22.

necessarily exclude investment costs that have already been sunk so that the parties must share the net benefits of exchange, known to economists as "quasi-rents." Inevitably, this leads to inefficiently low investment because the parties anticipate that they will not recover the full incremental returns to investment. Each party that invests only obtains a share of the returns to that investment and therefore will underinvest. For example, if the parties evenly divide the returns to exchange, they will only recover half of the incremental returns to investment. In contrast, binding contractual commitments will take into account the full incremental returns to investment and thus will generate efficient investment.

These three assumptions are unrealistic because in practice there are many institutions that mitigate or avoid the risk of "holdup." Rational behavior by market participants suggests that the combination of these three assumptions is unlikely to occur. First, it is apparent that binding contracts between buyers and sellers are a common occurrence, so the notion that contracting is impossible describes rare situations. Contract law protects the expectations of contracting parties for efficient contractual agreements that conform to various legal standards. Contract law provides remedies for breach of contract as well as flexibility in contract terms. Repeated interactions among buyers and sellers and the value of maintaining business reputations also help to enforce both formal and informal contractual agreements.

Second, buyers and sellers usually are not "locked" into relationships. Again, this describes a rare set of situations. Buyers and sellers operate in markets with multiple trading partners and multiple opportunities to form contractual relationships. Various market institutions provide flexibility in contracting. Buyers and sellers will seek to avoid such relational constraints if contracts cannot be enforced and if substantial transaction-specific investments would be required

Third, buyers and sellers will find ways to avoid making transaction-specific investments in the absence of contractual protections or when dealing with parties that do not have good reputations. Buyers and sellers can choose between making transaction-specific investments and generic investments that can be shifted to other market relationships. If there are concerns about relationship-specific investments the party benefitting from those investments can incur those costs.

The "patent holdup" idea presumes that a patent owner "holds up" a producer that infringes on the patent. There is no prior relationship between the patent owner and the infringer; instead the infringer is "surprised" to learn that he or she has infringed on a patent. Farrell, Hayes, Shapiro, and Sullivan observe that "[t]he difference between the ex post royalties and the ex ante royalties reflects the holdup power wielded by Patentee 1 as a result of the user's specific investment in Technology 1."[52] Shapiro argues that the fact that the

[52] Farrell, Hayes, Shapiro & Sullivan, *supra* note 1, at 665.

downstream firm *D* is "simply unaware" of the patent owner *P* "need not imply that *D* was derelict or actively ignoring or evading or willfully infringing *P*'s patent, given the large number of patents, many of which have broad and vague claims."[53] Shapiro's analysis takes the invention as given and focuses instead on manufacturer investments in implementing a standard and the risks they face from uncertainties in patent claims.

The three standard assumptions from the contractual "holdup" literature reappear in the patent context: first, the patent owner and the producer cannot negotiate a binding contract; second, the patent owner and the producer become "locked" in a relationship; and third, the producer has made "transaction-specific" investments. However, there is little, if any, evidence offered that these assumptions apply in practice in the patent context. Just as occurs with contractual "holdup," rational patent owners and patent users have incentives to avoid these problems.

First, the notion that patent owners and producers cannot negotiate binding contracts is contradicted by the existence of a highly active market for technology transfers including patent licensing. Patent owners and patent users have incentives to contract before any infringement occurs and before making investments in using the technology. Patent users such as producers have an incentive to determine whether there are relevant patents. If such a determination is difficult, producers have incentives to avoid infringement by licensing their technology from others or by developing proprietary technology. Second, even if a producer infringes on a patent, either intentionally or inadvertently, the patent owner and the producer are not necessarily locked into a relationship. The producer has the option of developing alternative technologies, licensing substitute technologies, or pursuing alternative activities that do not require the infringed technology. Third, if producers are concerned about the risk of infringement and the costs of investing in using patented technology, they have incentives to make investments in flexible technologies rather than technology-specific investments. If infringement occurs, patent owners and producers can negotiate licensing agreements.

The view that patent owners "hold up" infringers ignores inventors' irreversible investments in R&D and the risks that patent owners face due to possible infringement by manufacturers. Inventors face uncertainty and monitoring costs in detecting infringement. Inventors face high legal costs in seeking damages and injunctions as well as uncertainties in the working of the legal system. Inventors also face opposition by some antitrust regulators who seek to limit damages and injunctions. These costs and uncertainties increase the bargaining power of infringers relative to patent owners allowing some infringers to avoid paying any royalties and letting other infringers pay below-market royalties. This suggests that some patent owners may face the risk of "infringer holdup" by opportunistic producers. This is a particular concern in

[53] Shapiro, *Injunctions, Hold-Up, and Patent Royalties*, *supra* note 3, at 291 n.20.

light of rent seeking in the form of anti-patent lobbying by potential infringers who seek to avoid compensating IP owners.

2. *Traditional IE and the "Standards Holdup" Fallacy*

The "standards holdup" argument is a variant of the notion of "patent holdup" applied to patents that are included in standards. Farrell, Hayes, Shapiro, and Sullivan suggest that this phenomenon arises from either "deception or failure to disclose patents" or when "users assert that the patent holder is not meeting its duty to license in a reasonable fashion."[54] Farrell, Hayes, Shapiro, and Sullivan state that,

> [e]x ante, before an industry standard is chosen, there are various attractive technologies, but ex post, after industry participants choose a standard and take steps to implement it, alternative technologies become less attractive. Thus, a patent covering a standard may confer market power ex post that was much weaker ex ante. In the extreme, a standard could be built around initially arbitrary choices that become essential once the standard is established.[55]

Farrell, Hayes, Shapiro, and Sullivan suggest that technology standards are analogous to price-fixing: "Cooperative standard setting often involves horizontal competitors agreeing on certain specifications of the products they plan to market, implicating core antitrust issues regarding the boundary between cooperation and collusion."[56] They assert that "standards holdup" is "not merely a private contracting problem, but an antitrust problem."

The "standards holdup" argument is expansive and alarmist—the entire economy is allegedly locked in to a particular technology due to technology standards, thus blocking innovation. The FTC expresses concerns that "'[l]ock-in' can make an entire industry susceptible to holdup. In addition to higher prices and other economic harms, holdup in standards-based industries may discourage standard-setting activities and collaboration, which can harm innovation."[57] The FTC also maintains that "[h]old-up may have especially severe consequences for innovation and competition in the context of standardized technology."[58]

There is no empirical evidence for the alleged "patent holdup" and "standards holdup" problems. A variety of studies show an absence of empirical support for these concerns.[59] Technology standards are formed by consensus

[54] Farrell, Hayes, Shapiro & Sullivan, *supra* note 1, at 605.
[55] *Id.* at 607–08.
[56] *Id.*
[57] FTC REPORT, *supra* note 11, at 28.
[58] *Id.* at 22.
[59] *See* J. Gregory Sidak, *Holdup, Royalty Stacking, and the Presumption of Injunctive Relief for Patent Infringement: A Reply to Lemley and Shapiro*, 92 MINN. L. REV. 714 (2008); Damien Geradin & Miguel Rato, *Can Standard-Setting Lead to Exploitative Abuse? A Dissonant View on Patent Hold-Up, Royalty Stacking and the Meaning of FRAND*, 3 EUR. COMPETITION J. 101 (2007); Epstein, Kieff & Spulber, *supra* note 11.

with participation both by inventors and by producers, thus limiting any anticompetitive conduct. The process of standard setting involves repeated interaction among participants over many years and involves multiple releases of technological standards. This implies that patent owners who engage in anticompetitive conduct would be penalized in the next round of standard setting by other participants in the standards organization. Anticompetitive conduct would be further penalized by the marketplace and by competition among standards and among standard-setting organizations.

The theoretical arguments alleging anticompetitive conduct within standards organizations by patent owners are flawed as well.[60] The "standards holdup" argument again is based on the *ex ante-ex post* fallacy because it draws a distinction between the values of a patent before and after a technology standard is established. Technologies and associated standards are not cast in stone; there is continual innovation within standards, continual revision of standards, and continual development of new standards.

The "standards holdup" argument shifts the three assumptions made in the contractual "holdup" and the "patent holdup" settings to the standards context, again without any empirical evidence or logical support. First, the "standards holdup" argument incorrectly presumes that patent owners and producers cannot negotiate contracts before standards are established. Clearly this is inaccurate because patent owners and producers may choose to enter into technology transfer and licensing agreements at any stage of the standard-setting process. Also, inventors and producers engage in multiple bilateral negotiations over time, before, during and after standards are developed. Producers are informed about patents that read on a standard and they have both the incentive and the ability to influence what does and does not get included in technology standards. In some circumstances, it may be in the interest of patent owners and producers to contract after standards are established because of improved information about the nature of the standard, observation of technological changes that occur during and after standard setting, and better information about market conditions. Even after a standard is established, patent owners have incentives to negotiate royalties that encourage investment and increase utilization of their technologies.

Second, the "standards holdup" view assumes that a patent owner and producers are locked into a relationship. For example, Farrell, Hayes, Shapiro, and Sullivan argue that industry-level "coordination problems can make it especially hard to shift away from an agreed-upon standard in response to excessive royalty

[60] *See* John M. Golden, *"Patent Trolls" and Patent Remedies*, 85 TEX. L. REV. 2111 (2007); Geradin & Rato, *supra* note 59; Epstein, Kieff & Spulber, *supra* note 11. *See also* Einer Elhauge, *Do Patent Holdup and Royalty Stacking Lead to Systematically Excessive Royalties?*, 4 J. COMPETITION L. & ECON. 535, 535–36 (2008) ("close examination reveals problems in their models that undermine the validity of their conclusions and indicate quite the opposite: that current patent remedies often (arguably usually) result in royalty rates that are too low to sufficiently reward socially optimal invention.").

demands."[61] Yet producers that are concerned about the effects of standards on royalties will develop products and production processes accordingly. Competing standards and the availability of substitute technologies that conform to a standard allow producers to choose among competing technologies, as will be discussed further below. The notion that producers are surprised by technologies included in a standard stems from a flawed understanding of standards institutions. The transparent and consensus-based system of discussing technical contributions among inventors and manufacturers prior to their selection for inclusion in standards tends to eliminate surprises.

Third, the "standards holdup" argument maintains that the industry makes "transaction-specific" investments in complying with technology standards before negotiating licenses and therefore faces switching costs of adopting a non-infringing technology.[62] The patent owner is said to obtain incremental royalties from producers due to these switching costs. This conclusion is inconsistent with prior contracting between patent owners and producers. Producers have incentives to avoid infringement by obtaining licenses for their technology or by developing proprietary technology. If producers already adopted the technology before it is included in the standard and have already negotiated a licensing agreement, they would not be affected by the inclusion in the standard. If producers do not contract with patent owners prior to standards development and they are concerned about the adjustment costs resulting from technology adoption, they have incentives to make investments in flexible technologies rather than technology-specific investments.

What about the possibility that the industry is "surprised" by patents that read on a standard. This is unlikely to occur because the standard-setting process itself generates information about patents that will be included in the standard. SSOs have disclosure rules that require sharing information about patents, patent applications, and licensing terms. Even if producers invest before negotiating contracts, royalties are limited by patent owners' interest in promoting the usage of their technology. In addition, SSOs generally require that patent owners license their technologies on FRAND terms.[63] Even if producers and patent owners contract after standards are established, this need not indicate that producers have necessarily adopted the technology and made investments in implementing the technology.

Advocates for policies to address "patent holdup" and "standards holdup" suggest that injunctions contribute to these problems.[64] However, Peter Camesasca, Gregor Langus, Damien Neven, and Pat Treacy examine court

[61] Farrell, Hayes, Shapiro & Sullivan, *supra* note 1, at 616.

[62] *See* Farrell, Hayes, Shapiro & Sullivan, *supra* note 1, at 616 ("when standards are involved, an entire industry may make specific investments that are subject to holdup"); Lemley & Shapiro, *supra* note 1; Shapiro, *Injunctions, Hold-Up, and Patent Royalties*, *supra* note 3.

[63] *See* Lemley, *Intellectual Property Rights and Standard-Setting Organizations*, *supra* note 3.

[64] *See* Lemley & Shapiro, *supra* note 1; Shapiro, *Injunctions, Hold-Up, and Patent Royalties*, *supra* note 3; and Farrell, Hayes, Shapiro & Sullivan, *supra* note 1.

procedures in the United States and Europe and find a greater risk that producers will engage in "reverse holdup" that takes advantage of patent owners to obtain below-FRAND royalties.[65] Gregor Langus, Vilen Lipatov, and Damien Neven develop a model showing that even when injunctions are available to the patent owner, holders of a weak patent will end up with below-FRAND royalties, particularly when litigation costs are high. They further find that prospective licensees may prefer to litigate and the holder of a sufficiently strong patent will end up in litigation by rejecting offers below FRAND, particularly when litigation takes time and litigation costs are low.[66]

Empirical analysis of technology standards should carefully apply reduced-form and structural models that recognize the feedback effects of competitive conduct on the formation of technology standards. Empirical analysis in IE should control for endogeneity in studying interactions among technology standards, competition, innovation, and economic performance. Economic theory in IE is useful for examining how various assumptions about markets for IP and other institutions such as standards organizations affect economic outcomes. IE therefore provides guidance on how to make causal inferences from such economic data as IP, R&D costs, commercialization costs, royalties, and technology transactions.

III. PATENTS AND COMPETITION: INNOVATIVE SUBSTITUTES

Patent awards are not a source of market power. A patent provides its owners with rights to exclude access to an invention, not rights to exclude access to a market. To the contrary, patents are the foundation of competitive markets for inventions. Thus, patents make possible the commercialization of inventions and the supply of products that embody those inventions. Eliminating patent protections so as to promote competition would likely have the opposite effect; it would reduce incentives for invention and innovation, thus diminishing competition in the market for inventions. This part considers innovative efficiency when patents have innovative substitutes.

A. Patents and Market Power

Patents establish IP rights that allow the formation of markets for inventions. Patents offer inventors and producers a means of transferring or licensing inventions. Patents thus provide inventors with incentives to compete with each other in the market for inventions or in the market for products that embody inventions. Patents also provide producers with incentives to compete

[65] Peter Camesasca, Gregor Langus, Damien Neven & Pat Treacy, *Injunctions for Standard-Essential Patents: Justice Is Not Blind*, 9 J. COMPETITION L. & ECON. 285 (2013).

[66] Gregor Langus, Vilen Lipatov & Damien Neven, *Standard-Essential Patents: Who Is Really Holding Up (And When)?*, 9 J. COMPETITION L. & ECON. 253 (2013).

with each other to purchase or license inventions. Eliminating patent protections would serve to squash competition rather than limit monopoly.

A patent gives the inventor exclusivity of rights that are comparable with other forms of property rights such as real estate or corporate securities. As with other types of property, the inventor has the right to choose how the invention is used, the right to receive the services of the invention, and the right to commercialize the invention.[67] Although IP rights give some protection against infringement, which surely would erode economic rents, they are not a source of market power in the sale or licensing of inventions or in the sale of products that apply inventions.

Patents do not give inventors a prize for inventive effort because patents do not provide rewards for invention. Rather, inventors are rewarded by market returns from commercializing or applying their inventions, with no guarantees that inventions have any market value. As John Stuart Mill noted, "the reward conferred by it depends upon the invention's being found useful, and the greater the usefulness, the greater the reward; and because it is paid by the very persons to whom the service is rendered, the consumers of the commodity."[68]

Economists have long defended patents as a means of providing incentives to inventors to engage in R&D and to disclose their inventions. Yet, many economists continue to repeat the ancient fallacy that patents confer a "monopoly" on their owners.[69] Michele Boldrin and David Levine, for example, argue that patents provide "a monopoly as a reward for innovation" and that there is "little doubt that granting a monopoly for any reason has the equally ill consequences we associate with monopoly power."[70] But exclusivity of ownership of technology is not an economic monopoly.

The argument that patents confer economic monopolies was already well known and refuted in the nineteenth century patent controversy that reached a peak between 1850 and 1875 in England, France, Germany, Holland, and Switzerland.[71] John Stuart Mill observed that "the condemnation of monopolies ought not to extend to patents."[72] The controversy continues to the present day.

[67] *See* Armen A. Alchian, *Property Rights*, *in* THE CONCISE ENCYCLOPEDIA OF ECONOMICS (David R. Henderson ed., Liberty Fund 2008), *available at* http://www.econlib.org/library/Enc/PropertyRights.html (the three general aspects of property rights) (last visited Nov. 2, 2013).

[68] JOHN S. MILL, PRINCIPLES OF POLITICAL ECONOMY 932 (John W. Parker 1st ed. 1848), *quoted in* Fritz Machlup & Edith Penrose, *The Patent Controversy in the Nineteenth Century*, 10 J. ECON. HIST. 1 (1950).

[69] *See* WILLIAM D. NORDHAUS, INVENTION, GROWTH, AND WELFARE: A THEORETICAL TREATMENT OF TECHNOLOGICAL CHANGE ch. 5 (MIT Press 1969); William D. Nordhaus, *The Optimum Life of a Patent: Reply*, 62 AM. ECON. REV. 428 (1972); F.M. Scherer, *Nordhaus' Theory of Optimal Patent Life: A Geometric Reinterpretation*, 62 AM. ECON. REV. 422 (1972); Richard J. Gilbert & Carl Shapiro, *Optimal Patent Length and Breadth*, 21 RAND J. ECON. 106 (1990).

[70] Michele Boldrin & David K. Levine, *The Case Against Patents*, 27 J. ECON. PERSP. 3 (2013).

[71] Machlup & Penrose, *supra* note 68.

[72] MILL, *supra* note 68, *quoted in* Machlup & Penrose, *supra* note 68.

Edmund Kitch points out that there are "elementary and persistent errors in the economic analysis of intellectual property," noting particularly the incorrect assertion that exclusivity in IP corresponds to an economic monopoly.[73]

The mistaken notion that a patent is an economic monopoly represents a fundamental confusion between exclusive ownership of property and exclusive control over a market. Owning a patent for say a bicycle design is a far cry from having an economic monopoly of the market for bicycles, even if the bicycle design happens to be popular. There were patent disputes in the early days of bicycle development, but there continued to be markets for bicycles. A patent is the right to exclude infringers' access to IP, not a right to exclude suppliers' access to customers. Patent owners have exclusive ownership of their assets but do not have economic monopolies in the market for assets.

It is possible that a patent owner may have market power in the sale of an invention, but such market power is not due to the patent itself. The fact that most patents have little, if any, market value effectively demonstrates that patents in and of themselves are not a source of market power or economic rents. The market value of a patented invention depends on the characteristics of the invention, the value of the invention to potential users, and the availability of competing alternatives.

IP owners face competition from innovative substitutes, whether IP takes the form of patented inventions, products with brands and trademarks, or copyrighted works.[74] Patents are only part of the market for inventions, which includes many other types of disembodied and embodied technologies.[75] Furthermore, IP owners face competition from innovative complements that compete for economic rents. Buyers have alternatives that need not include patented inventions, including designing products and manufacturing processes to avoid using the patented invention.

Weakening IP rights would not reduce a patent owner's market power. This is because weakening IP rights would merely dissipate economic returns to invention by permitting infringement. To the contrary, weakening IP rights would reduce competition in the market for inventions by reducing the incentive of patent users to develop alternatives. Reducing entry of new inventions would diminish competition in the market for inventions. Also, weakening IP reduces incentives for patent users to participate in markets for inventions,

[73] Edmund W. Kitch, *Elementary and Persistent Errors in the Economic Analysis of Intellectual Property*, 53 VAND. L. REV. 1727 (2000). *See also* Edmund W. Kitch, *Nature and Function of the Patent System*, 20 J.L. & ECON. 265 (1977) ("This essay argues that the patent system performs a function not previously noted: to increase the output from resources used for technological innovation.").

[74] *See* Paul Goldstein, *Copyright*, 55 L. & CONTEMP. PROBS. 79 (1992); Christopher S. Yoo, *Copyright and Product Differentiation*, 79 N.Y.U. L. REV. 212 (2004).

[75] On the market for inventions, see Ashish Arora, Andrea Fosfuri & Alfonso Gambardella, *Markets for Technology and Their Implications for Corporate Strategy*, 10 INDUS. & CORP. CHANGE 419 (2001); Ashish Arora & Alfonso Gambardella, *Ideas for Rent: An Overview of the Market for Technology*, 19 INDUS. & CORP. CHANGE 775 (2010).

leading to greater reliance on secrecy and vertical integration to protect their discoveries.

Antitrust policy should not view patent ownership as a source of market power. The Antitrust Guidelines for Licensing of Intellectual Property state that "[t]he Agencies will not presume that a patent, copyright, or trade secret necessarily confers market power upon its owner."[76] The Justice Department and the FTC recognize competition among innovative substitutes:

> Although some intellectual property rights may create monopolies, intellectual property rights do not necessarily (and indeed only rarely) create monopolies because consumers may be able to substitute other technologies or products for the protected technologies or products. Therefore, antitrust doctrine does not presume the existence of market power from the mere presence of an intellectual property right.[77]

Even if a patent owner is the sole supplier of an invention or of a product that uses an invention, the patent does not confer monopoly power. The patent owner faces competition from potential entry of substitute inventions and innovative products. Potential competition for an invention limits the royalties on inventions or limits the prices that can be charged for products that apply the patented invention. Put differently, patent owners and users take into account continued invention and the resulting technological improvements that can make the patented technology obsolete. Thus, even in the absence of innovative substitutes, the potential entry of future inventions limits the market power of patent owners. If patent owners do have market power, the expected returns to invention help to provide incentives for other inventors to produce new inventions.

Potential competition from future inventions and innovations is consistent with the modern IO perspective on market power. Even highly concentrated industries, including those with only one active firm, need not lead to an economic monopoly; potential entry is sufficient to provide price competition for

[76] *See* FTC ANTITRUST GUIDELINES, *supra* note 48, at 4. The DOJ and the FTC recognize competition among inventors with substitute inventions:

> An innovation market consists of the research and development directed to particular new or improved goods or processes, and the close substitutes for that research and development. The close substitutes are research and development efforts, technologies, and goods that significantly constrain the exercise of market power with respect to the relevant research and development, for example by limiting the ability and incentive of a hypothetical monopolist to retard the pace of research and development. The Agencies will delineate an innovation market only when the capabilities to engage in the relevant research and development can be associated with specialized assets or characteristics of specific firms.

Id. at 11. This approach understates competition by focusing on incumbent firms; the innovation market also should include potential entry of new firms.

[77] U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, ANTITRUST ENFORCEMENT AND INTELLECTUAL PROPERTY RIGHTS: PROMOTING INNOVATION AND COMPETITION 2 (2007), *available at* www.justice.gov/atr/public/hearings/ip/222655.pdf.

an incumbent firm.[78] This contrasts with the traditional IO model of an economic monopoly within the "Structure-Conduct-Performance" paradigm, which maintains that if there is only one firm in the industry, it can engage in monopolistic conduct such as reducing its output and raising prices, thus leading to welfare losses in comparison to perfect competition.

Patents provide inventors with an *opportunity* to earn economic rents, not a *guarantee*. Expectation of market returns helps to give inventors incentives to create substitute inventions—leading to competition on the supply side of the market for inventions. The number of competing inventors entering the marketplace is endogenous and jointly determined by the competitive conduct of inventors. The entry of competing inventors and their competitive conduct thus depend on such exogenous factors as the size of the market for inventions, the costs and risks of invention and commercialization, and the underlying scientific and technological opportunities. The number of competing inventors who develop and offer substitute inventions affects the market power and competitive conduct of inventors. In turn, the competitive conduct of inventors affects their decisions to engage in R&D and enter the market for inventions.

The returns from applying inventions, net of the costs of purchasing or licensing inventions, gives producers incentives to obtain the best inventions—leading to competition on the demand side of the market for inventions. Producers bid against each other to purchase inventions. The demand for inventions is a derived demand based on downstream product markets. Figure 4 is a representation of the market for inventions. Because inventions affect product features, production processes, and transaction methods, the number of inventors and competitive conduct of inventors is interdependent with the market structure and competitive conduct of firms in downstream industries, which also are endogenous and jointly determined. The characteristics of final consumer demand, including the number of consumers and consumer tastes and income, thus affect the derived demand for inventions.

Market returns to patent ownership are subject to many sources of fundamental uncertainty that limit expected returns. The patent owner does not know whether efforts to develop the invention into a useful product, manufacturing process, or transaction method will be successful. The patent owner faces commercialization uncertainty regarding the adoption of the invention and negotiations over royalties. There is uncertainty about the derived demand for inventions reflecting uncertainty about consumer demand for product features, adoption of new technologies by producers, and competition from present and future substitute technologies. The patent owner's right to

[78] *See* Joseph Bertrand, *Review of A. A. Cournot, Recherches sur les Principes Mathématiques de la Théorie de la Richesse and L. Walras, Théorie Mathématique de la Richesse Sociale*, 67 J. DES SAVANTS 499 (1883); Harold Demsetz, *Why Regulate Utilities?*, 11 J.L. & ECON. 55 (1968); William J. Baumol, *Contestable Markets: An Uprising in the Theory of Industry Structure*, 72 AM. ECON. REV. 1 (1982).

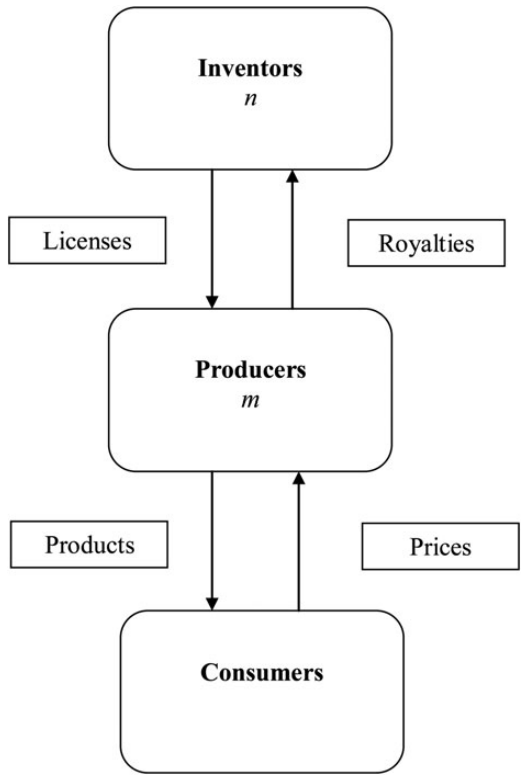

Figure 4. Interaction between the market for inventions and the product market

exclude is itself subject to uncertainty; regulatory and legal decisions can affect the validity and breadth of the patent.[79]

Inventors compete with producers who can invest in developing their own inventions. Invention and production can be carried out by separate actors or vertically integrated so that the industrial organization of the markets for invention and production is also of critical importance. Established producers and entrepreneurial startups face Coasian "make-or-buy" choices between in-house R&D and obtaining technologies in the market for inventions.[80] Reinhilde Veugelers and Bruno Cassiman find that small firms choose

[79] Mark A. Lemley & Carl Shapiro, *Probabilistic Patents*, 19 J. ECON. PERSP. 75, 75 (2005) ("economists have increasingly recognized that a patent does not confer upon its owner the right to exclude but rather a right to try to exclude by asserting the patent in court. . . . When a patent holder asserts its patent against an alleged infringer, the patent holder is rolling the dice. If the patent is found invalid, the property right will have evaporated."). *See also* Carl Shapiro, *Antitrust Limits to Patent Settlements*, 34 RAND J. ECON. 391 (2003).

[80] *See* ALFRED D. CHANDLER, THE VISIBLE HAND: THE MANAGERIAL REVOLUTION IN AMERICAN BUSINESS (Harvard Belknap 1977); DAVID B. AUDRETSCH, INNOVATION AND INDUSTRY EVOLUTION (MIT Press 1995).

between R&D and purchasing inventions, whereas larger firms combine R&D activities with external purchases of inventions.[81] Gabriele Pellegrino, Mariacristina Pivaa, and Marco Vivarelli show that for "young innovative companies," innovation intensity mainly depends on embodied technical change from external sources rather than in-house R&D, while in-house R&D plays a more important role for mature innovative firms.[82]

IP rights do not in themselves confer market power to patent owners any more than property rights to land or equity in corporations generate market power. Excluding access to IP limits infringement just as property rights to land limit trespass. Patents are a temporary government grant of the right to exclude access to IP conditional on disclosure and other requirements. Traditional criticisms of patents suggest that IP is not comparable to other forms of property because patents lead to legal disputes, yet this objection is not backed by evidence. In contrast to the few high-profile cases that generate media coverage, less than 2 percent of patents generate such disputes, and less than 0.2 percent of issued patents go to court.[83] Conversely, other forms of property also generate legal cases—disputes over land are as old as civilization itself, and the history of law is replete with cases involving real property.[84] Corporate equity also generates many legal cases such as shareholder lawsuits, but that does not make a case against shareholder ownership of corporations.

Traditional criticisms of patents allege that IP does not offer well-defined boundaries such as those in land.[85] Adam Mossoff points out in response that both IP and real estate offer similar problems of boundary definition and comparable degrees of legal complexity:

> If the boundaries of the patent system are to be compared to that of real estate, then commentators and judges must include the doctrines that secure the temporal, geographic and functional dimensions and which together define the scope of a property right secured in an estate. The trespass fallacy must be discarded and the comparisons made anew based on the proper conceptual counterpart to patents—estates. Commentators and judges should stop talking about patent boundaries in terms of fences, as this analogy has led them astray, and instead they should be talking about *estate boundaries*.[86]

[81] Reinhilde Veugelers & Bruno Cassiman, *Make and Buy in Innovation Strategies: Evidence from Belgian Manufacturing Firms*, 28 RES. POL'Y 63 (1999).

[82] Gabriele Pellegrino, Mariacristina Pivaa & Marco Vivarelli, *Young Firms and Innovation: A Microeconometric Analysis*, 23 STRUCTURAL CHANGE & ECON. DYNAMICS 329 (2012).

[83] Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 NW. U. L. REV. 1495 (2001).

[84] *See, e.g.*, LESLEY ADKINS & ROY A. ADKINS, HANDBOOK TO LIFE IN ANCIENT ROME 177 (Facts on File 2004) (discussing land disputes between plebs and patricians in ancient Rome).

[85] *See, e.g.*, JAMES BESSEN & MICHAEL J. MEURER, PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATORS AT RISK (Princeton Univ. Press 2008); Boldrin & Levine, *supra* note 70.

[86] Adam Mossoff, *The Trespass Fallacy in Patent Law* (George Mason L. & Econ. Research Paper No. 12-54, 2012), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2126595.

Mossoff notes that, "[i]n fact, the hyper-technical and highly formalistic estate interests are very similar to patents in both content and form." Mossoff further observes that "overlapping estate interests are similar to the overlapping patent interests covering a single product or process, which often precipitates extensive litigation known today as a 'patent thicket.'"[87]

B. The Market for Patents

The traditional economic model of patents simply *assumes* that patent owners have monopoly power. The assumption that patent owners have economic monopolies mischaracterizes the market for inventions and is not based on empirical observation. The standard framework assumes that the patent owner is a monopoly inventor that faces no competition from substitutes or complements. The assumption that the inventor is a monopolist also appears in models of patent races. Inventors compete before a patent is awarded but the winner of the patent race is a monopolist.[88] However, the market power of the winner is necessarily mitigated when patent holders face competition after a patent is awarded.[89]

The traditional assumption that patent owners have an economic monopoly is equivalent to assuming that patents generate monopoly rents. Additionally, inventions are assumed to be non-rivalrous so that the benchmark price for evaluating the efficiency of inventions equals zero.[90] The monopoly power and non-rivalrous invention assumptions lead to the conclusion that patents create economic inefficiencies. In Kenneth Arrow's classic model, for example, the inventor is assumed to be able to extract monopoly rents from the entire downstream industry:

> In an ideal socialist economy, the reward for invention would be completely separated from any charge to the users of the information. In a free enterprise economy, inventive activity is supported by using the invention to create property rights; precisely to the extent that it is successful, there is an underutilization of the information. The property rights may be in

[87] *See* Adam Mossoff, *The Rise and Fall of the First American Patent Thicket: The Sewing Machine War of the 1850s*, 53 ARIZ. L. REV. 165 (2011) *(*showing how private ordering dealt with patent complements in sewing machines).

[88] *See* Lawrence M. DeBrock, *Market Structure, Innovation, and Optimal Patent*, 28 J.L. & ECON. 223 (1985); Jennifer F. Reinganum, *The Timing of Innovation: Research, Development, and Diffusion*, *in* 1 HANDBOOK OF INDUSTRIAL ORGANIZATION 849 (Richard Schmalensee & Robert D. Willig eds., Elsevier 1989); Michael R. Baye & Heidrun C. Hoppe, *The Strategic Equivalence of Rent-Seeking, Innovation, and Patent-Race Games*, 44 GAMES & ECON. BEHAV. 217 (2003).

[89] *See* Vincenzo Denicolò, *Patent Races and Optimal Patent Breadth and Length*, 44 J. INDUS. ECON. 249 (1996); Ignatius Horstmann, Glenn M. MacDonald & Alan Slivinski, *Patents as Information Transfer Mechanisms: To Patent or (Maybe) Not to Patent*, 93 J. POL. ECON. 837 (1985).

[90] Inventions are said to be "non-rivalrous" when they are a form of information that can be used by multiple individuals, in contrast to scarce goods in which one individual's consumption reduces the amount of the good available for others.

> the information itself, through patents and similar legal devices, or in the intangible assets of the firm if the information is retained by the firm and used only to increase its profits.[91]

Arrow's view is that governments should provide prizes for invention and that inventions should be distributed freely to potential users. Harold Demsetz responds that efficient invention is best achieved by "a private property system that reduces the cost of contracting and raises the cost of free-loading while, at the same time, it provides incentives and guidance for investment in producing information."[92]

The many advantages of a price system argue against the notion of free inventions. As Demsetz points out, rewarding inventors, deterring infringement, and allocating inventions among users entail transaction costs. R&D is costly and complex so that incentives for invention require more than prizes. Commercialization of inventions also is a complex process that requires knowledge and effort. Although some types of inventions are "non-rivalrous" information goods, the earnings from commercialization of inventions by competing users are rivalrous. When inventors have tacit knowledge about their inventions, applying inventions may require effort by inventors, making the use of the invention rivalrous.[93]

Although many, if not most, inventions do not earn royalties, one should not take zero royalties to be an ideal benchmark. Patented inventions necessarily differ so that their value in use may differ depending on the particular application.[94] Inventors may command some economic rents based on the advantages of their invention over others in those particular applications. The fact that some inventors receive royalties from their inventions should not be interpreted as an indication of monopoly because the returns reflect the advantages of the invention in competition with substitute inventions. The royalties earned by inventors also reflect transaction costs in the market for inventions, which can be significant due to the complexities of search, bargaining, and contracting.

Patent policy recommendations based on the assumption that patents generate market power yield predictable inaccuracies. Economists often identify the task of government policy toward IP as choosing the life of the patent so as to trade off incentives to invent with efficiency losses from the patent owner's market power.[95] In this setting, the greater the inventor's market power the lower will be the optimal patent life. This setting is generalized by assuming

[91] Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, *in* THE RATE AND DIRECTION OF INVENTIVE ACTIVITY 609, 615 (Nat'l Bureau of Econ. Research 1962).

[92] Harold Demsetz, *Information and Efficiency: Another Viewpoint*, 12 J.L. & ECON. 1 (1969).

[93] *See* Daniel F. Spulber, *Tacit Knowledge with Innovative Entrepreneurship*, 30 INT'L J. INDUS. ORG. 641 (2012).

[94] Damien Geradin, Anne Layne-Farrar & A. Jorge Padilla, *Royalty Stacking in High Tech Industries: Separating Myth from Reality* (Center for Econ. Pol'y Research Discussion Paper No. 0701, 2007).

[95] *See, e.g.*, NORDHAUS, INVENTION, GROWTH, AND WELFARE, *supra* note 69.

that the government's choice of patent breadth limits the patent holder's market power.[96] This approach suggests that there is a tradeoff between the life and breadth of patents. In this setting, a policy maker achieves the same reward to inventors for various combinations of patent life and breadth. The policy maker maintains the same reward by reducing the inventor's market power in each period through reductions in patent breadth and corresponding increases in the life of the patent. This approach may not yield efficient public policies because it may not represent an accurate characterization of patent breadth. The traditional approach takes patent breadth to be a measure of market access rather than the characteristics of the invention.

The specific characteristics of patents do not generate market power for patent owners. The length of the patents granted by the government affects the period of time that the IP owner can obtain returns, but the returns themselves are determined by markets for inventions. The breadth of patents potentially affects the extent of differentiation among competing inventions, but the returns to patent owners are limited by demand for the inventions and the reactions of competitors. It is certainly necessary for patent examiners and courts to carefully address patent claims. However, even if patent claims limit alternatives within a category of technology, this does not necessarily limit economic substitutes that may employ inventions in different categories of technologies. For example, patented technologies for drink cartons face competition from technologies used for other types of containers made from metals, glass, paper, or plastics. Again, anticipation of rents attracts entry of inventors and encourages producers to find substitutes.

C. The Effects of Competitive Pressures on Incentives to Invent

By defining IP rights, patents lower the transaction costs of markets for inventions. By allowing patent owners to exclude, markets for inventions can allocate access to technology to the highest-value users.[97] Buyers and sellers can form agreements that implement inventions in developing new product designs, manufacturing techniques, and commercial transactions. When there is a market for inventions, competition among inventors and among producers who use inventions stimulates invention and innovation.[98] Thus, IP rights help generate innovative efficiency.

[96] *See* Pankaj Tandon, *Optimal Patents with Compulsory Licensing*, 90 J. POL. ECON. 470 (1982); Gilbert & Shapiro, *Optimal Patent Length and Breadth*, *supra* note 69; Paul Klemperer, *How Broad Should the Scope of Patent Protection Be?*, 21 RAND J. ECON. 113 (1990); Donald J. Wright, *Optimal Patent Breadth and Length with Costly Imitation*, 17 INT'L J. INDUS. ORG. 299 (1999).

[97] Exclusivity of control also prevents inefficient competition to invest in developing the technology, as suggested by the "prospect theory." *See* Kitch, *supra* note 73.

[98] *See* sources cited *supra* note 10.

Just as other types of markets yield information about the value of goods and services, markets for inventions help to discover the value of inventions. The market returns to patents depend on both the supply of and demand for patented technologies. The supply of patented technologies is not exogenously determined so that it is not possible to infer that patent owners have market power based on the number of competing technologies. The market power of patent owners is endogenously determined through entry and competition among inventors. Competition among inventors over time will serve to limit the economic rents from invention. Inventors also face competition from potential buyers who choose among alternative technologies and alternative applications of technologies.

The anticipation of market returns provides incentives for inventors to develop new inventions through investment in R&D. Patents generate market returns in various ways. First, owners license patents to producers in return for royalties. Second, owners transfer patents to others through sales, referred to as assignments. The United States Patent and Trademark Office (USPTO) registers patent transfers in their Patent Assignment Database. Carlos Serrano finds that the most active sellers are individual private inventors and small innovators and notes that the highest rates of transfers occur in information and communications technology (ICT) and the pharmaceutical and medical industries.[99] Third, patent transfers can occur through mergers and acquisitions involving companies that own patent portfolios. Fourth, the returns to patents also are realized through the application of patented technology by their owners to produce and market goods and services. This includes both established firms and new firms established by entrepreneurs. Fifth, firms that own patents can realize returns through cross licensing and reciprocity agreements with other firms that own patents. The benefits of reciprocity agreements include access to technology and protection from infringement claims resulting from use of patented technology.

The market value of patents is constrained by the elasticity of demand for the asset, the competition from substitutes and complements, and the reactions of competing suppliers of IP. The demand for a patented technology is a derived demand. The patented technology is not a final consumption good; it must be embodied in a production process, product design or other application. The demand for the patented technology thus derives from the demand for products produced by firms applying the patented technology. The ability to raise prices on the sale or license of a patent is constrained by the elasticity of the derived demand for the patent. If the derived demand for a patented technology is highly price elastic, the patent owner does not have the ability to raise prices on the sale or license of the patent.

[99] *See* Carlos J. Serrano, *The Dynamics of the Transfer and Renewal of Patents*, 41 RAND J. ECON. 686 (2010). *See also* Alberto Galasso, Mark Schankerman & Carlos J. Serrano, *Trading and Enforcing Patent Rights*, 44 RAND J. ECON. 275 (2013).

The availability of substitute technologies—patented or otherwise—affects the elasticity of demand for a particular invention. Even if inventions are scientifically unique, difficult to copy, or protected by a patent, there often are alternative inventions that are substitutes in demand. The demand for an invention will be highly price elastic if there are close substitutes available. Also, the availability of substitute products and production processes that use other technologies affects the derived demand for an invention. The demand for the products or production processes that use the patented technology affects the elasticity of the derived demand for the patented invention. The demand for the invention will be highly price elastic if there are close substitutes available for the products and production processes that use the patented invention.

Competition among suppliers of patented inventions and other technologies also limits the market power of patent owners. The potential earnings of IP owners provide incentives for other IP owners to develop inventions and enter the market for inventions, thus dissipating economic rents. Competition among suppliers of patented inventions need not be perfect because patented inventions are unlikely to be perfect substitutes. Potential competition from future inventors also limits the market power of patent owners because producers will have less demand for technologies that they expect will soon become obsolete.

Competitive pressures increase incentives to invent and to innovate when there is a market for inventions. Greater competition on the demand side, that is, among producers who use inventions, creates greater incentives for invention and innovation.[100] This result holds because greater competition among producers who use inventions generates lower prices for final products and greater efficiency in product markets, which in turn provides greater demand and thus greater rents for inventors. This is consistent with Arrow's well-known result that a perfectly competitive product market generates a greater incentive to invent than a monopolistic product market because greater product-market rivalry increases revenues for independent inventors.[101] Demand side competition among producers stimulates invention and innovation with general Bertrand and Cournot competition among producers.[102]

Greater competition on the supply side of the market for inventions, that is, among inventors who provide inventions, also creates greater incentives for invention and innovation.[103] This is because the average returns to competing

[100] *See* sources cited *supra* note 10.

[101] Arrow, *supra* note 91.

[102] *See* Spulber, *How Do Competitive Pressures Affect Incentives to Innovate When There Is a Market for Inventions?*, *supra* note 10.

[103] *See* sources cited *supra* note 10. On the implications of international markets for inventions, see also Daniel F. Spulber, *Innovation and International Trade in Technology*, 138 J. ECON. THEORY 1 (2008); Daniel F. Spulber, *The Quality of Innovation and the Extent of the Market*, 80 J. INT'L ECON. 260 (2010).

inventors exceed the incremental returns to a monopoly inventor that engages in parallel R&D projects. Although competition among inventors dissipates economic rents, competitive entry of inventors generates more R&D projects than the multi-project monopoly inventor.

When there are weak protections for IP rights, inventors and producers must incur additional transaction costs to compensate inventors and apply their inventions. As a consequence, weak IP rights result in less reliance on markets for inventions and greater reliance on vertical integration of invention and production. The replacement of markets for invention by vertical integration entails inefficiencies. Vertical integration that is driven by the need to protect IP entails costs of governing organizations, resulting in inefficiencies in comparison to markets for IP. Also, vertical integration combined with secrecy results in inefficiencies because of the benefits of disclosing inventions that accompany a patent system.

Weakening IP protections that increase vertical integration at the expense of markets for invention generates another important inefficiency. When invention and production are vertically integrated, competition tends to diminish incentives to invent and to innovate. Many theoretical studies in economics show that competition diminishes incentives to invent when R&D and production are vertically integrated.[104] The literature recognizes that R&D investment and market structure are determined jointly in a market equilibrium.[105] Given vertically integrated R&D and production, Vives shows that competitive pressures in the product market, as measured by the number of producers or producer entry costs, reduce incentives to innovate, and competitive pressures as measured by market size and demand elasticity tend to

[104] *See* Morton I. Kamien & Nancy L. Schwartz, *On the Degree of Rivalry for Maximum Innovative Activity*, 90 Q.J. ECON. 245 (1976); Partha Dasgupta & Joseph E. Stiglitz, *Industrial Structure and the Nature of Innovative Activity*, 90 ECON. J. 266 (1980); Partha Dasgupta & Joseph E. Stiglitz, *Uncertainty, Industrial Structure, and the Speed of R&D*, 11 BELL J. ECON. 1 (1980); Richard J. Gilbert & David M. G. Newbery, *Preemptive Patenting and the Persistence of Monopoly*, 72 AM. ECON. REV. 514 (1982); Michael Spence, *Cost Reduction, Competition, and Industry Performance*, 52 ECONOMETRICA 101 (1984); Pankaj Tandon, *Innovation, Market Structure, and Welfare*, 74 AM. ECON. REV. 394 (1984); Helmut Bester & Emmanuel Petrakis, *The Incentives for Cost Reduction in a Differentiated Industry*, 11 INT'L J. INDUS. ORG. 519 (1993); Larry D. Qiu, *On the Dynamic Efficiency of Bertrand and Cournot Equilibria*, 75 J. ECON. THEORY 213 (1997); Luis M.B. Cabral, *R&D Competition when Firms Choose Variance*, 12 J. ECON. & MGMT. STRATEGY 139 (2003); SUTTON, SUNK COSTS AND MARKET STRUCTURE, *supra* note 7; JOHN SUTTON, TECHNOLOGY AND MARKET STRUCTURE: THEORY AND HISTORY (MIT Press 1998); Xavier Vives, *Innovation and Competitive Pressure*, 56 J. INDUS. ECON. 419 (2008).

[105] *See, e.g.*, Almarin Phillips, *Patents, Potential Competition, and Technical Progress*, 56 AM. ECON. REV. 301 (1966); Dasgupta & Stiglitz, *Industrial Structure and the Nature of Innovative Activity*, *supra* note 104; Dasgupta & Stiglitz, *Uncertainty, Industrial Structure, and the Speed of R&D*, *supra* note 104; Partha Dasgupta, *Patents, Priority and Imitation or, the Economics of Races and Waiting Games*, 98 ECON. J. 66 (1988); Tandon, *Innovation, Market Structure, and Welfare*, *supra* note 104; Vives, *supra* note 104.

increase incentives to innovate with vertical integration.[106] Elsewhere, I show that even when vertically integrated firms share inventions through a patent pool, competition among the members of the patent pool reduces incentives for R&D due to free rider problems and implicit collusion.[107] The different effects of competition when there are markets for inventions versus when there is vertical integration helps to explain the debate over the effects of competition on incentives to innovate.[108]

Assuming that R&D and production are vertically integrated and implicitly assuming that there is no market for inventions, Schumpeter argues that competition decreases innovation. Schumpeter advances the hypothesis that firms with more market power have greater returns to innovation and larger firms have economies of scale in R&D.[109] This view accorded with market conditions in the first half of the twentieth century; practically all funded research in the United States and Europe took place in corporate or government R&D labs.[110] Schumpeter worried that the social function of entrepreneurship was "already losing importance" as "bureaucratic administration of large enterprises tend to make innovation itself a routine matter and to substitute the activities of committees and teams of experts for individual initiative."[111]

The Schumpeterian hypothesis—size and market power increase incentives to innovate—influenced a large number of empirical studies that also focus on firms that vertically integrate R&D and production.[112] Extensive empirical analysis offers mixed results on the relationship between competition and innovation. Many of these studies take market concentration as exogenous and examine the effects of market structure on innovation.[113] Franklin Fisher and

[106] Vives, *supra* note 104.

[107] Spulber, *How Do Competitive Pressures Affect Incentives to Innovate When There Is a Market for Inventions?*, *supra* note 10.

[108] The legal literature also considers the effects of competitive pressures on innovation. *See* Richard T. Rapp, *The Misapplication of the Innovation Market Approach to Merger Analysis*, 64 ANTITRUST L.J. 19 (1995); Richard J. Gilbert, *Looking for Mr. Schumpeter: Where Are We in the Competition-Innovation Debate?*, *in* 6 INNOVATION POLICY AND THE ECONOMY 159 (Adam B. Jaffe, Josh Lerner & Scott Stern eds., Nat'l Bureau of Econ. Research 2006); Jonathan B. Baker, *Beyond Schumpeter vs. Arrow: How Antitrust Fosters Innovation*, 74 ANTITRUST L.J. 575 (2007); Michael A. Carrier, *Two Puzzles Resolved: Of the Schumpeter-Arrow Stalemate and Pharmaceutical Innovation Markets*, 93 IOWA L. REV. 393 (2008).

[109] JOSEPH A. SCHUMPETER, CAPITALISM, SOCIALISM AND DEMOCRACY (1942).

[110] Bo Carlsson, Zoltan J. Acs, David B. Audretsch & Pontus Braunerhjelm, *Knowledge Creation, Entrepreneurship, and Economic Growth: A Historical Review*, 18 INDUS. CORP. CHANGE 1193, 1194 (2009).

[111] SCHUMPETER, *supra* note 109, at 132.

[112] Much earlier, Schumpeter had observed that competition increases innovation because entrepreneurs who challenge incumbent firms engage in "creative destruction." *See* JOSEPH A. SCHUMPETER, THEORIE DER WIRTSCHAFTLICHEN ENTWICKLUNG (1912), *translated as* THE THEORY OF ECONOMIC DEVELOPMENT (Harvard Univ. Press 1934).

[113] Franklin M. Fisher & Peter Temin, *Returns to Scale in Research and Development: What Does the Schumpeterian Hypothesis Imply?*, 81 J. POL. ECON. 56 (1973) (citing Henry H. Villard, *Competition, Oligopoly, and Research*, 66 J. POL. ECON. 483 (1958); Jacob Schmookler, *Bigness,*

Peter Temin criticize empirical tests of the Schumpeterian hypothesis, pointing out problems with empirical findings of advantages for larger firms based on tests of economies of scale in R&D.[114] As John Sutton points out, the dispute over the direction of causation from market concentration to R&D intensity "faded out in the late 1970s with the widespread acceptance of the view that these were both endogenous variables and they should be seen as being simultaneously determined within an equilibrium system."[115]

More recent empirical studies recognize that innovation and market structure are endogenously and jointly determined and test the effects of market demand and entry costs on innovation.[116] However, as Gregory Sidak and David Teece state: "Despite 50 years of research, economists do not appear to have found much evidence that market concentration has a statistically

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Fewness, and Research, 67 J. POL. ECON. 628 (1959); James S. Worley, *Industrial Research and the New Competition*, 69 J. POL. ECON. 183 (1961); Edwin Mansfield, *Industrial Research and Development Expenditures: Determinants, Prospects, and Relation to Size of Firm and Inventive Output*, 72 J. POL. ECON. 319 (1964); Daniel Hamberg, *Size of Firm, Oligopoly, and Research: The Evidence*, 30 CAN. J. ECON. POL. SCI. 62 (1964); F.M. Scherer, *Size of Firm, Oligopoly, and Research: A Comment*, 31 CAN. J. ECON. POL. SCI. 256 (1965); F.M. Scherer, *Firm Size, Market Structure, Opportunity, and the Output of Patented Inventions*, 55 AM. ECON. REV. 1097 (1965); William S. Comanor, *Research and Technical Change in the Pharmaceutical Industry*, 47 REV. ECON. STAT. 182 (1965); William S. Comanor, *Market Structure, Product Differentiation, and Industrial Research*, 81 Q.J. ECON. 639 (1967); Jesse W. Markham, *Market Structure, Business Conduct, and Innovation*, 55 AM. ECON. REV. 323 (1965); Henry Grabowski & Dennis Mueller, *Industrial Organization: The Role and Contribution of Econometrics*, 60 AM. ECON. REV. 100 (1970)). *See also* Joel B. Rosenberg, *Research and Market Share: A Reappraisal of the Schumpeter Hypothesis*, 25 J. INDUS. ECON. 101 (1976) (finding a negative relationship between internal R&D, as measured by the percentage of total employment allocated to R&D, and the firm's market share). The Schumpeterian Hypothesis also is related to studies of the "differential productivity growth puzzle." *See, e.g.*, Richard R. Nelson & Sidney G. Winter, *In Search of Useful Theory of Innovation*, 6 RES. POL'Y 36 (1977) (and references therein).

[114] Fisher & Temin, *supra* note 113.

[115] John Sutton, *Schumpeter Lecture: Technology and Market Structure*, 40 EUR. ECON. REV. 511 (1996).

[116] *See* Albert N. Link, *Firm Size and Efficient Entrepreneurial Activity: A Reformulation of the Schumpeter Hypothesis*, 88 J. POL. ECON. 771 (1980); Zoltan J. Acs & David B. Audretsch, *Innovation, Market Structure, and Firm Size*, 69 REV. ECON. STAT. 567 (1987); Zoltan J. Acs & David B. Audretsch, *Innovation in Large and Small Firms: An Empirical Analysis*, 78 AM. ECON. REV. 678 (1988); Reinhard Angelmar, *Market Structure and Research Intensity in High-Technological-Opportunity Industries*, 34 J. INDUS. ECON. 69 (1985); Stephen J. Nickell, *Competition and Corporate Performance*, 104 J. POL. ECON. 724 (1996); Sutton, *Schumpeter Lecture*, *supra* note 115; SUTTON, TECHNOLOGY AND MARKET STRUCTURE, *supra* note 104; Richard Blundell, Rachel Griffith & John Van Reenen, *Market Share, Market Value and Innovation in a Panel of British Manufacturing Firms*, 66 REV. ECON. STUD. 529 (1999); Howard A. Shelanski, *Competition and Deployment of New Technology in U.S. Telecommunications*, 2000 U. CHI. LEGAL F. 85; Philippe Aghion, Nicholas Bloom, Richard Blundell, Rachel Griffith & Peter Howitt, *Competition and Innovation: An Inverted U Relationship*, 120 Q.J. ECON. 701 (2005); Pedro L. Marin & Georges Siotis, *Innovation and Market Structure: An Empirical Evaluation of the 'Bounds Approach' in the Chemical Industry*, 55 J. INDUS. ECON. 93 (2007).

significant impact on innovation."[117] Sutton points out that "there appears to be no consensus as to the form of relationship, if any, between R&D intensity and concentration."[118] Richard Blundell, Rachel Griffith, and John Van Reenen argue that "[t]he results from applied work on market structure and innovation have been disturbingly sensitive to data source and estimation technique."[119] A survey of fifty years of empirical research by Wesley Cohen finds, "[d]espite the consensus regarding the importance of demand, appropriability, and technological opportunity conditions in affecting innovative activity and performance, consideration of the role of these variables still has a considerable distance to go."[120] Cohen adds: "However banal, the prescription that modeling can serve as a useful handmaiden to empirical analysis has often been overlooked in studies of innovation."[121]

IV. PATENTS AND COMPETITION: INNOVATIVE COMPLEMENTS

This part shows that patent awards do not generate market power with innovative complements, including owners of SEPs. The previous part argues that competition from substitute technologies limits the market power of inventors and the market power of producers applying patented inventions. This part considers the argument that patents are a source of market power when complementary inventions are used in combination to make a final product.

Some suggest that technology standards confer market power of owners of SEPs who are said to benefit from demand for complementary inventions. However, this causality is again incorrect because technology standards and competitive conduct are endogenous and jointly determined. Complementary inventions need not be necessary for the production of an innovation. Even without innovative substitutes, suppliers of innovative complements compete for returns from downstream producers. When producers use multiple complementary inventions, competition from actual and potential innovative substitutes for each invention is sufficient to limit market power. Finally, private

[117] J. Gregory Sidak & David Teece, *Dynamic Competition in Antitrust Law*, 5 J. COMPETITION L. & ECON. 581 (2009).

[118] SUTTON, TECHNOLOGY AND MARKET STRUCTURE, *supra* note 104, at 4.

[119] Blundell, Griffith & Van Reenen, *supra* note 116. *See also* Wesley M. Cohen & Richard C. Levin, *Empirical Studies of Innovation and Market Structure*, *in* 2 HANDBOOK OF INDUSTRIAL ORGANIZATION 1059 (Richard Schmalensee & Robert D. Willig eds., Elsevier 1989).

[120] Wesley M. Cohen, *Fifty Years of Empirical Studies of Innovative Activity and Performance*, *in* 1 HANDBOOK OF THE ECONOMICS OF INNOVATION 129, 194 (Bronwyn H. Hall & Nathan Rosenberg eds., North Holland 2010). Cohen further observes that "[a]lthough some descriptive evidence has begun to accumulate on how the nature and effects of demand, opportunity, and appropriability differ across industries, there have been few efforts to collect original data on these variables." *Id.* at 194.

[121] *Id.* at 198.

ordering including standards organizations can address potential coordination problems associated with pricing innovative complements.[122]

A. Complementary Monopolies and the "Tragedy of the Anticommons" Revisited

Public policy debates related to IP tend to be dominated by colorful charges of institutional and market failure. Some economists and legal scholars argue that technology standards confer market power on owners of SEPs due to the "complements problem."[123] The complements problem is said to cause a coordination failure known as the "patent thicket" that prevents the innovations that require complementary inventions. The "tragedy of the anticommons" is said to cause inefficiencies due to "excessive property rights" when there are complementary technologies.[124] Complementary inventions also are alleged to lead to "royalty stacking" that increases the total royalties charged to producers. Owners of patents for complementary technologies are claimed to engage in "holdout" to drive up their royalties, thus diminishing the output and profits of the downstream industry. These types of market failure concerns are founded on a number of highly unrealistic assumptions.

1. Innovative Complements Do Not Imply That Inventions Are Necessary

First, many economic analyses of complementary inventions assume that each of the complementary inventions is necessary to produce the final product. However, the complementary of inventions does not imply that they are necessary.[125] For example, applications programs are innovative complements to the devices on which they run. The Apple App Store offers 375,000 applications for the iPad and over 900,000 applications for the iPhone, not to mention myriad complementary accessories.[126] Most of these applications are certainly not necessary. There should not be a presumption that complementary inventions are necessary for a particular product or production process.

[122] *See* Spulber, *Unlocking Technology*, *supra* note 16.

[123] *See, e.g.*, Shapiro, *Injunctions, Hold-Up, and Patent Royalties*, *supra* note 3.

[124] *See* Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621 (1998); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCIENCE 698 (1998); MICHAEL A. HELLER, THE GRIDLOCK ECONOMY: HOW TOO MUCH OWNERSHIP WRECKS MARKETS, STOPS INNOVATION, AND COSTS LIVES (Basic Books 2008).

[125] In economic theory, inputs that "perfect complements" are necessary to produce a particular output. In practice, many complementary inputs are not perfect complements—that is, they are not necessary.

[126] *See iPad*, APPLE, https://www.apple.com/ipad/from-the-app-store/*; iPhone 5c*, APPLE, http://www.apple.com/iphone-5c/app-store/. Returns per download for application developers appear to vary considerably by technology platform: Android (2 cents), Apple (10 cents), and Microsoft (15 cents). *See* Tristan Louis, *How Much Do Average Apps Make?*, FORBES (Aug. 10, 2013, 5:30 PM), http://www.forbes.com/sites/tristanlouis/2013/08/10/how-much-do-average-apps-make/?utm_campaign=forbestwittersf&utm_source=twitter&utm_medium=social.

Patented inventions can be optional even when they are innovative complements. Complementary inventions that are declared "essential" to a technology standard also can be optional components because they are optional in the design of the platform and because declarations that patents are "essential" do not generally correspond to necessity. When complementary inventions are optional, users can choose the best combination of inventions based on their cost and contribution to the innovation.

2. Innovative Complements May Have Innovative Substitutes

Second, economic models of complementary inventions tend to assume an absence of innovative substitutes within each category. This assumption is reflected in models of the "tragedy of the anticommons" and discussions of "patent thickets" and the "complements problem." Assuming that all complements are necessary and assuming that there are no substitute inventions generate the conclusion that every supplier of a complementary invention has market power. The presence of substitutes would serve to limit the royalties of the complementary inventions. Suppose, for example, that there is an initial substitute technology that can replace the entire bundle of complementary technologies. The presence of a substitute technology imposes a constraint on the total royalties offered by the suppliers of the complementary inventions. The total royalties offered by owners of complementary inventions cannot exceed the incremental benefits of the bundle of complements as compared to the initial substitute technology. Suppliers of complementary inventions have incentives to limit their royalties to generate demand for the bundle of new technologies.

There may be substitute technologies available for each type of complementary technology. The pricing of each technology is limited by competition from the substitute. Anne Layne-Farrar, Jorge Padilla, and Richard Schmalensee point out that perfect competition for each of the complementary technologies is sufficient to rule out any problems of technology adoption and pricing between patent holders and producers.[127] They further suggest that when there is no competition for at least one of the necessary technologies, owners of complementary technologies may absorb all of the rents of downstream producers.[128] However, this conclusion assumes that technology owners have all of the bargaining power when negotiating with producers and that the extent of competition among technology owners is given exogenously.

The potential entry of inventors supplying substitute technologies implies that the extent of competition for complementary inventions is endogenous.

[127] On competition within categories of complementary technologies, see Layne-Farrar, Padilla & Schmalensee, *supra* note 40. Scott D. Kominers & E. G. Weyl, *Holdout in the Assembly of Complements: A Problem for Market Design*, 102 AM. ECON. REV. 360 (2012) (considering seller competition within "clusters" associated with each complement).

[128] Layne-Farrar, Padilla & Schmalensee, *supra* note 40.

The returns to applying complementary inventions will attract competition from inventors offering substitute inventions in each of the categories. Total royalties across the categories of complementary technologies will be limited by competition from substitute technologies within each category. Producers will consider the incremental returns from adopting the best technology in each category rather than the second-best technology in one or more categories. When substitute inventions compete within categories, producers obtain positive net benefits from adopting complementary inventions, that is, the royalties from complementary products need not exhaust economic rents. The returns obtained by inventors in each of the categories of technology are endogenous and jointly determined.

Some discussions of the "complements problem," such as that of James Buchanan and Yong Yoon, do not explicitly account for the benefits that producers receive from adopting innovative complements. The profits of the downstream industry do not depend on the quality of the complementary technologies and the number of complements used to produce the product. However, producers would not apply complementary technologies in the absence of incremental returns. The effect of this assumption is to exaggerate the efficiency losses that result from entry of inventors and non-cooperative pricing of complementary inventions by IP owners. Entry serves merely to divide the rents of producers and dissipate those rents by non-cooperative pricing. The "tragedy of the anticommons" thus presumes that inventors compete for shares of a fixed prize.

3. Inventors Who Supply Innovative Complements Have Market Entry Costs

Third, some economic analyses assume that inventors who provide innovative complements have *zero* entry costs. The absence of substitutes suggests that inventors who provide innovative substitutes have *prohibitive* entry costs. Based on these assumptions, for example, Buchanan and Yoon conclude that "[t]he common facility or resource tends toward total abandonment, its potential value being wasted in idleness."[129] The assumed asymmetry in entry costs drives the conclusion in a transparent manner.

The assumption of asymmetry of entry costs is certainly unrealistic because inventors' R&D and commercialization costs do not depend on whether they are supplying innovative complements or substitutes. The effect of these assumptions is to exaggerate the "tragedy of the anticommons" effect due to unlimited entry of suppliers of complementary inventions and the absence of entry of suppliers of substitute inventions. The assumption that complementary inventions are costless generates the conclusion that the output and rents of the downstream industry tend toward zero as the number of upstream

[129] James M. Buchanan & Yong J. Yoon, *Symmetric Tragedies: Commons and Anticommons*, 43 J.L. & ECON. 1 (2000).

owners increases. When there are entry costs for inventors of complementary inventions, the "tragedy of the anticommons" does not happen.

B. Complementary Monopolies and Private Ordering

This part explores various private ordering solutions when there are complementary inventions. Discussions of the "complements problem" and the "tragedy of the anticommons" often assume that is no private ordering solution to the coordination problem. For example, Buchanan and Yoon assume that "Coase-like contracts among users and excluders . . . are, for some reason, impracticable. A generalized 'transactions costs' explanation may be adduced here, but its specific relevance becomes relatively more important in the anticommons setting."[130] Inefficiencies occur because inventors who own complementary inventions cannot coordinate their royalty demands on the downstream industry. In the absence of private ordering, public ordering through antitrust and government regulation of IP then becomes necessary to address the problem of "excessive property rights."

The standard economic analyses of "complements problem" and "tragedy of the anticommons" discussions apply Cournot's classic model of complementary monopolies.[131] In this classic model dating back to 1838, complementary monopolies choose high prices. This is because without coordination, competing owners of complementary choose prices that are greater than what would be chosen by a monopolist for the same bundle of inputs. In the IP context, an absence of coordination implies that IP owners would choose royalties greater than what would be chosen by a monopolist that owned the bundle of complementary technologies.[132] Greater total royalties lower production in the downstream industry resulting in inefficiency: generating the "complements problem and the "tragedy of the anticommons."

The problem with this analysis from the point of view of public policy is that it depends on an assumed absence of coordination among IP owners. Policy recommendations are founded on the unrealistic assumption that IP owners and producers will not be able to communicate or to negotiate agreements. However, the potential inefficiencies from high prices provide incentives for coordination among inventors and coordination between inventors and producers. Private ordering in the market for inventions can occur when the benefits

[130] *Id.*

[131] Antoine A. Cournot, *Researches into the Mathematical Principles of the Theory of Wealth* (1838). Cournot gave the example of a producer that combines copper and zinc in fixed proportions to make brass, when there is a monopoly supplier of copper and a monopoly supplier of zinc. *See, e.g.*, Buchanan & Yoon, *supra* note 129. *See also* Norbert Schulz, Francesco Parisi & Ben Depoorter, *Fragmentation in Property: Towards a General Model*, 158 J. INST. THEOR. ECON. 594 (2002).

[132] *See, e.g.*, Hugo Sonnenschein, *The Dual of Duopoly Is Complementary Monopoly: Or, Two of Cournot's Theories Are One*, 76 J. POL. ECON. 316 (1968).

of coordination are greater than transaction costs. Private ordering also depends on there being well-defined property rights. In the market for inventions, patents and other forms of IP help to lower transaction costs.

As Ronald Coase points out in the context of externalities, private bargaining results in efficient solutions to the problem of social costs when transaction costs are not too high.[133] Coase emphasizes that with small numbers of participants there may be lower bargaining costs, which also potentially applies to the problem of complementary technologies.[134] As I emphasize elsewhere, there are various mechanisms for private ordering when there are large numbers of market participants.[135]

First, inventors with complementary inventions can coordinate directly with each other to lower total royalties for the bundle of inventions toward the monopoly outcome. Firms that own patents can combine their patents to form patent portfolios through mergers and acquisitions (M&A). Then, the owner of the patent portfolio can offer producers access to the patent portfolio. Thus, private ordering solutions can address the "complements problem" in the absence of actual or potential innovative substitutes. Even if IP owners have all of the bargaining power, private ordering solutions reduce double marginalization, non-cooperative pricing, and holdout.

Second, inventors can coordinate through market intermediaries by selling their patents to aggregators. Aggregators consolidate their patents into portfolios and offer access to producers.[136] Intermediaries in the market for inventions improve the allocation of inventions by coordinating prices of complementary inventions. Just as with products and financial assets, IP intermediaries reduce transaction costs in the market for IP through market-making and matchmaking activities. Patent dealers and other intermediaries invest in transaction processes needed to buy and sell IP.[137] IP intermediaries provide matchmaking and liquidity in IP markets, thus increasing the returns to invention. Perhaps most significantly, patent dealers help to enforce property rights by investing in legal action that is not available to financially constrained inventors and entrepreneurs. Critics who label IP intermediaries as "patent trolls" misrepresent their activities by ignoring the contributions of these intermediaries to market efficiency.[138] IP intermediaries are similar to other intermediaries that play important roles throughout the economy including retail, wholesale,

[133] Ronald Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960).

[134] *Id.*

[135] Spulber, *Unlocking Technology*, *supra* note 16. *See also* Daniel F. Spulber, *Consumer Coordination in the Small and in the Large: Implications for Antitrust in Markets with Network Effects*, 4 J. COMPETITION L. & ECON. 1 (2008).

[136] *See* Andrei Hagiu & David B. Yoffie, *The New Patent Intermediaries: Platforms, Defensive Aggregators, and Super-Aggregators*, 27 J. ECON. PERSP. 45 (2013).

[137] *See* James F. McDonough, *The Myth of the Patent Troll: An Alternative View of the Function of Patent Dealers in an Idea Economy*, 56 EMORY L.J. 189 (2006).

[138] Other terms for "patent trolls" include "non-practicing entities" (NPEs), "patent-assertion entities" (PAEs), or "patent monetizing entities" (PMEs).

and financial markets. Far from being non-productive, market intermediaries account for a significant share of GDP.[139]

Third, when inventors are firms that vertically integrate R&D and production, they can coordinate by forming patent pools and cross licensing their inventions. Patent pooling and cross-licensing arrangements are commonly employed by competing producers. Mossoff reviews the history of the sewing machine wars of the 1850s.[140] Mossoff shows how the first patent pool in the United States successfully solved the complex problem of coordination with complementary technologies, contrary to the view that private ordering is not feasible with "patent thickets."[141] Although cooperative arrangements have long raised antitrust policy concerns, they can contribute to economic efficiency. Richard Gilbert reviews a century of antitrust policy toward technology sharing and argues that royalty-free cross licensing is unlikely to harm competition and can benefit competition by increasing access to efficient technology.[142]

Finally, inventors, whether independent or vertically integrated, can coordinate through negotiation with downstream producers. Some analyses of complementary monopolies assume that inventors have all the bargaining power and make take-it-or-leave-it offers to downstream producers, resulting in free-rider effects that are interpreted as "royalty stacking." Other analyses assume that buyers have all the bargaining power and make take-it-or-leave-it offers to sellers, resulting in holdouts. Because of asymmetric information, there is a chance that buyers' offers are too low, leading to rejected offers that are interpreted as holdouts, particularly when the number of sellers is very large.[143] In between these possibilities, buyers and sellers can engage in a set of bilateral negotiations. When transaction costs are not too high, a set of bilateral negotiations allows technology sellers to lower total royalties and technology buyers to earn positive returns. This is a generalization of the Coase theorem that allows for multiple bilateral negotiations as a means of addressing the problem of social cost.[144]

The various forms of private ordering that occur in IP suggest that concerns over the "complements problem" or the "tragedy of the anticommons" may be misplaced. A number of other observations further suggest that these policy concerns are without empirical foundation. The ICT industries offer an extensive variety of products and exhibit rapid pace of technological change, which suggest that innovative complements are not limiting product and process innovation. Additionally, the great technological complexities of ICT products,

[139] Daniel F. Spulber, *Market Microstructure and Intermediation*, 10 J. ECON. PERSP. 135 (1996).
[140] Mossoff, *The Rise and Fall of the First American Patent Thicket*, *supra* note 87.
[141] *Id.*
[142] Richard J. Gilbert, *Antitrust for Patent Pools: A Century of Policy Evolution*, 2004 STAN. TECH. L. REV. 3.
[143] Kominers & Weyl, *supra* note 127.
[144] Coase, *supra* note 133.

many of which involve multiple patented technologies suggest that the benefits of coordination exceed transaction costs.

The complexity of innovations and the inclusion of complementary inventions in many products indicate successful private ordering institutions. In contrast, the evidence for the "complements problem" and the "tragedy of the anticommons" is indirect and circumstantial.[145] Simply counting SEPs includes both innovative complements and innovative substitutes, and certainly does not indicate that particular inventions are necessary for the final product. Many studies seek to identify "patent thickets" on the basis of patent citations. The patent citation approach also does not distinguish between innovative complements and substitutes or indicate whether particular patents are necessary for particular innovations. As Kirti Gupta points out, patent citation measures do not provide an indication of what patents are included in particular products or whether ownership is diffuse or concentrated.[146]

V. CONCLUSION: TECHNOLOGY STANDARDS AND ANTITRUST POLICY

Technology standards, competitive conduct, and economic performance are jointly determined through markets and cooperative institutions. Technology standards cannot in themselves serve as a basis for antitrust policy because technology standards and innovation are equilibrium outcomes. The existence of technology standards and the number of SEPs provide little if any evidence that owners of SEPs have market power. Owners of SEPs generally face competition from innovative substitutes and innovative complements. The potential for new inventions and innovations further constrains the market value of SEPs and limits royalties. The existence of technology standards and the number of SEPs provides little if any evidence to support such policy concerns as the "complements problem," "patent thickets," the "tragedy of the anticommons," "standards holdup," or "royalty stacking."

Technology standards do not determine competitive conduct or economic performance because they reflect the competitive strategies of inventors and producers. In addition, technology standards reflect innovative efficiencies generated by competition and cooperation among inventors and producers. Technology standards often emerge through market competition among inventors and producers and consumer choices based on the benefits of competing products. Technology standards established by standards organizations emerge through voluntary participation and consensus decision making by inventors and producers. Standards organizations choose technology

[145] Kirti Gupta, *The Patent Policy Debate in the High-Tech World: A Literature Review*, 9 J. COMPETITION L. & ECON. 827 (2013); Richard A. Epstein & Bruce Kuhlik, *Is There a Biomedical Anticommons?*, 27 REGULATION 54 (2004); Fiona Murray & Scott Stern, *Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge?: An Empirical Test of the Anti-Commons Hypothesis*, 63 J. ECON. BEHAV. & ORG. 648 (2007).

[146] Gupta, *supra* note 145.

standards based on available technological alternatives, potential technological innovations, the requirements of producers that apply inventions, and consideration of market competition.

Technology standards encourage competitive conduct and economic performance for a number of reasons. Standard setting is a dynamic process: invention and innovation affect technology standards through development, revision and replacement, and conversely, technology standards provide incentives for additional invention and innovation. Technology standards reduce the transaction costs of modularity, foster specialization and division of labor, and promote competition of inventors and producers within standards. Policy makers also should consider competition among technology standards, competition among products across technology standards, and competition among standards organizations.

Public policy toward technology standards is particularly important given the critical economic contributions of IP-intensive industries. A study by the Economics and Statistics Administration and the USPTO finds that growth in IP-intensive industries outpaced gains in all non-IP intensive industries.[147] Rather than indicating technological lock-in and market power, evolving technology standards provide important indications of technological change. Antitrust policy and IP policy should avoid imposing special restrictions on SEPs or the process of setting technology standards. Such restrictions run the risk of impeding the interplay among technology standards, competitive conduct, and economic efficiency.

[147] Economics & Statistics Administration (ESA) & U.S. Patent & Trademark Office (USPTO), Intellectual Property and the U.S. Economy: Industries in Focus vii (2012), *available at* www.uspto.gov/news/publications/IP_Report_March_2012.pdf.