INTELLECTUAL CONTRACT AND INTELLECTUAL LAW

Daniel F. Spulber[*]

Abstract

Technological change is altering the nature of contract toward a greater focus on intangible assets. The direction of technological change toward greater connectivity, interoperability, mobile communications, the Internet of Things (IoT), artificial intelligence (AI), virtual inventions, and cooperative research and development (R&D) has profound implications. This Article develops a new framework that I refer to as "Intellectual Law" to address this shift. It will introduce the new concept of "Intellectual Contract" (IC) to characterize an agreement for invention, innovation, and technology adoption. This Article also introduces the concept of "Intellectual Tort" (IT) to describe liability including but not limited to misappropriation of trade secrets and infringement of patents, trademarks, and copyrights. Intellectual Law provides a consistent framework for IC, IT and Intellectual Property (IP). The article observes that legal protections for inventors cannot rely solely on what has proven to be a flawed combination of IT and IP. This Article argues that greater emphasis on IC rules would improve both IT and IP. Because an IC protects expectation interests, it is essential for creating, developing, sharing, and applying intangible assets. An IC generates gains from trade that enhance the benefits of inventors, innovators and adopters beyond what can be achieved by IT and IP alone. The discussion sets forth some broad principles for IC law, examines the differences between an IC and a standard contract, and identifies the main forms of ICs.

* Elinor Hobbs Distinguished Professor of International Business and Professor of Strategy, Strategy Department, Kellogg School of Management, Northwestern University, 2211 Campus Drive, Evanston, IL, 60208; Professor of Law (Courtesy), Pritzker School of Law, Northwestern University. E-mail: jems@kellogg.northwestern.edu. I gratefully acknowledge research support from Qualcomm and the Kellogg School of Management. I thank Alexei Alexandrov, Robert Merges, Ivan Png, Danny Sokol, and Andrew Toole for their helpful comments on an earlier draft. I also thank participants at the Eleventh Annual Searle Center/USPTO Conference on Innovation Economics, June 21–22, 2018, Northwestern University Pritzker School of Law.

INTRODUCTION

Conceptual legal frameworks must catch up with fundamental technological change. Major technological developments include dramatic increases in digital connectivity and interoperability as well as significant advances in Information and Communications Technology (ICT).[1] These technological shifts drive what has been called the Fourth Industrial Revolution (4IR).[2] Important innovations that involve digital connectivity and interoperability include the Internet of Things (IoT), artificial intelligence (AI), cloud computing, data analytics, mobile communications, autonomous vehicles, additive manufacturing, and virtual reality.[3]

1. YANN MÉNIÉRE ET AL., EUROPEAN PATENT OFFICE, PATENTS AND THE FOURTH INDUSTRIAL REVOLUTION: THE INVENTIONS BEHIND DIGITAL TRANSFORMATION 17 (European Patent Office ed., 2017) ("[T]he combined use of a wide range of new technologies in a large variety of sectors of the economy. These include digitisation and highly effective connectivity, but also technologies such as cloud computing and artificial intelligence that have permitted the development of interconnected smart objects operating autonomously.").

2. Klaus Schwab, *The Fourth Industrial Revolution: What It Means and How to Respond*, FOREIGN AFFAIRS (Dec. 12, 2015), https://www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolution ("The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres."); *see also* KLAUS SCHWAB, THE FOURTH INDUSTRIAL REVOLUTION (2017).

3. *See* MÉNIÉRE, *supra* note 1, at 17–18.

Achieving digital connectivity involves the formation of networks with many companies providing network components and connecting devices to the network, including mobile communications and autonomous vehicles. Companies require contracts to coordinate digital connectivity. As Spulber and Yoo observe, "networks come from supply decisions by network providers, interconnection between networks, demand decisions by network customers, and supply decisions by providers of complementary services."[4] The many types of access to networks, including retail, wholesale, interconnection, platform, and unbundled access, generally require contracts between firms.[5]

Firms also share knowledge through the formation of innovation networks.[6] The modular organization of production means that many firms are involved in the production of components and assembly of the final product.[7] Innovative products that contain new types of components and introduce inventions require knowledge of the technology of each component and knowledge about how to combine these technologies.[8] Complex innovations in particular require the combination of many new technologies.[9] Firms must make contractual agreements to obtain the components and to make sure they interoperate effectively. Firms creating complex innovations thus require contracts to coordinate inventive and innovative activities.

This Article introduces the concepts of "Intellectual Contract" (IC) and "Intellectual Tort" (IT) to advance and broaden the legal analysis of technological change and intangible assets. IC, IT, and Intellectual Property (IP) are becoming increasingly important given the rate and direction of technological change and greater focus on intangible assets. The principles of common law still apply to intangible assets.[10] However,

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4. DANIEL F. SPULBER AND CHRISTOPHER S. YOO, NETWORKS IN TELECOMMUNICATIONS: ECONOMICS AND LAW 39 (2009).

5. Daniel F. Spulber & Christopher S. Yoo, *Network Regulation: The Many Faces of Access*, 1 J. COMP. L. & ECON. 635 (2005).

6. *See, e.g.*, Charles Dhanasai & Arvind Parkhe, *Orchestrating Innovation Networks* 31 ACAD. MGMT. REV. 659, 659 (2006); *see generally* Eric Von Hippel, *Horizontal Innovation Networks—By and for Users*, 16 INDUS. & CORP. CHANGE 293 (2007).

7. Kim B. Clark, *The Interaction of Design Hierarchies and Market Concepts in Technological Evolution*, 14 RES. POL'Y 235, 235 (1985); Rebecca M. Henderson & Kim B. Clark, *Architecture Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms*, 35 ADMIN. SCI. Q. 9, 11 (1990); Karl Ulrich, *The Role of Product Architecture in the Manufacturing Firm*, 24 RES. POL'Y 419, 419 (1995).

8. Henderson & Clark, *supra* note 7, at 2.

9. Daniel F. Spulber, *Licensing Standard Essential Patents: Bargaining and Incentives to Invent* (Feb. 20, 2019) available at SSRN: https://ssrn.com/abstract=3338997.

10. *See* Richard Epstein, *Intellectual Property and the Law of Contract: The Case Against "Efficient Breach,"* 9 EUR. REV. OF CONT. L. 345 (2013); *see also* RICHARD EPSTEIN, SIMPLE RULES FOR A COMPLEX WORLD (1995).

IC, IT, and IP lack a framework that addresses the important additional implications of technological change and intangible assets.

Accordingly, this Article introduces a framework, referred to as "Intellectual Law," to reflect major developments in legal practice and economic activity. Intellectual Law is central to myriad legal cases, including over 5,000 patent case filings per year in the U.S.[11] Copyright infringement cases in Federal District Court numbered 5,042 in 2015 and 3,944 in 2016.[12] Trademark infringement cases totaled 38,486 between 2009 and 2017, with 8,502 of those cases overlapping with commercial claims.[13] Litigation in federal courts involving trade secrets has also increased.[14] All areas of IP are expanding rapidly; the US Patent and Trademark Office (USPTO) has granted over 10 million patents and handled over 9 million trademark applications or registrations.[15] One estimate puts the value of IP in the US at over $5 trillion.[16]

This Article argues there is a need for a general Intellectual Law framework that approaches IC, IT, and IP consistently and sheds light on their interactions. The proposed new framework of Intellectual Law will contribute to Science and Technology Law.[17] The purpose of the

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11. Chris Barry et al., *2017 Patent Litigation Study: Change on the Horizon?*, PWC https://www.pwc.com/us/en/forensic-services/publications/assets/2017-patent-litigation-study.pdf (last visited Aug. 7, 2017). There is also significant trademark litigation. William Bryner, *U.S. Trademark and Unfair Competition Litigation*, INT'L TRADEMARK ASS'N (Sept. 2017), https://www.inta.org/trademarkadministration/Documents/2017/Bryner%20-%20U.S.%20Trademark%20and%20Unfair%20Competition%20Litigation%2009142017/Bryner%20-%20U.S.%20Trademark%20and%20Unfair%20Competition%20Litigation%2009142017.pdf.

12. *Copyright Infringement Litigation Fell 22 Percent in FY 2016*, TRACREPORTS (Nov. 21, 2016), http://trac.syr.edu/tracreports/civil/445/.

13. Steve Brachman, *Lex Machina's 2017 Trademark Litigation Report Shows High Percentage of Overall Damages Awarded on Default Judgment*, IPWATCHDOG (Dec. 5, 2017), http://www.ipwatchdog.com/2017/12/05/2017-trademark-litigation-report-damages-awarded-default-judgment/id=90683/.

14. David Almeling et al., *A Statistical Analysis of Trade Secret Litigation in Federal Courts*, 45 GONZ. L. REV. 291, 293 (2009).

15. *See Patents Through History*, USPTO, https://10millionpatents.uspto.gov/ (last visited Nov. 11, 2018); *Trademark Case Files Dataset*, USPTO, https://www.uspto.gov/learning-and-resources/electronic-data-products/trademark-case-files-dataset-0 (last visited Nov. 11, 2018); *see also* Stuart Graham et al., *The USPTO Trademark Case Files Dataset: Descriptions, Lessons, and Insights*, 22 J. OF ECON. & MGMT. STRATEGY 669, 669–705 (2013).

16. Robert Shapiro & Kevin Hassett, *The Economic Value of Intellectual Property*, SONECON 2, http://www.sonecon.com/docs/studies/IntellectualPropertyReport-October2005.pdf (last visited Nov. 11, 2018).

17. *See generally* CARA MORRIS & JOSEPH CARVALKO, THE SCIENCE AND TECHNOLOGY GUIDEBOOK FOR LAWYERS (2014); *ABA Groups: Section of Science and Technology Law*, AM. B. ASS'N, https://www.americanbar.org/groups/science_technology/about_us.html (last visited Sept. 19, 2018) ("The mission of the ABA Section of Science & Technology Law is to provide leadership on emerging issues at the intersection of law, science, and technology; to promote

framework is to approach scientific issues and technological change in a more integrated fashion. Practitioners and scholars should avoid the costs and effort of reinventing the wheel when encountering each new technological development.

IP differs from traditional property because of differences between intangible and tangible assets. These differences affect the completeness, excludability, and transferability of intangible assets. ICs differ fundamentally from traditional contracts because ICs must handle problems that arise in inducing cooperative investment in intangible assets. ITs differ from traditional torts because of the additional difficulties in determining validity and infringement of IP and finding remedies for infringement.[18]

Intellectual Law has become essential because technological change has increased the economic importance of intangible assets relative to that of tangible assets. Investment in knowledge is a major driver of economic growth.[19] The U.S. national income accounts began to recognize R&D investment as part of Gross Domestic Product (GDP) as of 2013.[20] Private industry invests about two-thirds of annual R&D expenditures in the U.S., which amounted to over $527 billion in 2017.[21] U.S. investment in intangible assets exceeds $1 trillion per year, with a capitalized value of over $6 trillion.[22] Intangible assets constitute about 85% of the total market value of the S&P 500 companies.[23]

This Article devises the concept of Intellectual Contract to characterize an agreement to create, develop, share, or apply intangible assets involved in technological change. An IC has the standard contract features of offer, acceptance, and consideration, but differs from contracts that involve tangible assets. ICs include agreements related to traditional

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sound policy and public understanding on such issues; and to enhance the professional development of its members.").

18. For further discussion of problems related to infringement damages, see Daniel F. Spulber, *Finding Reasonable Royalty Damages: A Contract Approach to Patent Infringement*, 2019 ILL. L. REV. (forthcoming 2019).

19. Charles Hulten, *Stimulating Economic Growth Through Knowledge-Based Investment* (OECD Sci., Tech. & Industry, Working Paper No. 2, 2013), http://www.observatorioabaco.es/biblioteca/docs/412_OECD_WP_02_2013.pdf.

20. FRANCISCO MORIS ET AL., NAT'L SCI. FOUND., R&D RECOGNIZED AS INVESTMENT IN U.S. GDP STATISTICS: GDP INCREASE SLIGHTLY LOWERS R&D-TO-GDP RATIO (2015), https://www.nsf.gov/statistics/2015/nsf15315/.

21. *U.S. R&D: Slow Growth and Opportunities*, 2017 GLOBAL R&D FUNDING FORECAST, Winter 2017, at 7.

22. Leonard I. Nakamura, *What Is the U.S. Gross Investment in Intangibles? (At Least) One Trillion Dollars a Year!* 5 (Fed. Res. Bank of Phila., Working Paper No. 01-15, 2001).

23. Cate M. Elsten & Nick Hill, *Intangible Asset Market Value Study?*, 52 J. OF THE LICENSING EXEC. SOC'Y INT'L 245, 245–47 (2017); BARUCH LEV, INTANGIBLES: MANAGEMENT, MEASUREMENT, AND REPORTING (2001); Baruch Lev, *Remarks on the Measurement, Valuation, and Reporting of Intangible Assets* 17 (N.Y.U. Working Paper No. 2451–27468, 2003).

types of IP, that is, trade secrets, patents, trademarks, and copyrights. However, ICs also include non-traditional intangible assets such as knowledge, discoveries, inventions, innovations, and adoption of innovations that are not covered by standard IP. ICs not only include the upper tail of inventions covered by IP and IT but step in to cover the lower tail of ideas not covered by IP. ICs make adjustments to contracts to address the particular problem of creating and using knowledge. Technological change favoring intangible assets and interoperability makes ICs highly valuable and perhaps more commonly used than traditional contracts. The many types of IC identified here play an increasingly important role in fostering technological advances.

IC rules help resolve the debate over whether IP or IT is best for protecting the interests of inventors. Technological change requires cooperative investments in invention, innovation, and adoption. ICs protect the expectation interests of parties engaged in technological change: employer and employee, firm and subcontractor, and licensor and licensee. ICs not only protect inventors who make discoveries, but also innovators who apply those discoveries and adopters who demand innovations. ICs generate gains from trade that increase joint benefits for inventors, innovators, and adopters. When there are gains from trade, the inventor's returns from entering into an IC are greater than returns from either their own use of IP or an assignment to others. Because of gains from trade, ICs increase the benefits of inventors beyond what can be achieved with only IP and IT. Legal protections for inventors, innovators, and adopters thus cannot be based solely on a combination of IT and IP. Greater emphasis on IC rules by the courts within the Intellectual Law framework proposed here would address problems with both IT and IP.

I also devise the new term Intellectual Tort to designate liability rules governing the taking or infringement of intangible assets. IT includes misappropriation of trade secrets, and infringement of patents, trademarks, and copyrights. I argue that IC rules help disentangle IT rules from IP rules and overcome the shortcomings of IT rules. Many practitioners and scholars emphasize liability protections against infringement.[24] Daniel Crane introduces the term "Intellectual Liability" to identify the shift toward liability protections: "Instead of speaking about 'intellectual property,' it may be more appropriate to speak about

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24. *See, e.g.*, Ted Sichelman, *Purging Patent Law of "Private Law" Remedies*, 92 TEX. L. REV. 517, 519 (2013) ("[P]atent remedies mirror traditional tort law remedies by attempting to restore the patentee to the *status quo ante*—namely, the state of the world in which there is no infringement of the patent.").

'intellectual rights' consisting in part of intellectual property rights and in part of intellectual liability rights."[25]

Damage remedies based on IT, however, can fail to fully compensate IP owners or to deter infringement. In contrast, IC rules support agreements between IP owners and users that can both prevent infringement and resolve infringement disputes without the need for courts to determine compensation. When infringement does occur, the courts can use IC rules as a framework for calculating reasonable royalty damages, as I argue elsewhere.[26] Thus, IC rules complement IT rules by helping deter infringement and determine reasonable royalties that are compensatory.

Technological change is altering the nature of contract. ICs provide agreements needed to achieve technological change, both within the firm and among firms. I suggest that ICs have five important features that distinguish them from standard contracts involving tangible assets.

First, ICs address the lack of completeness in ownership of intangible assets. An important strength of ICs is that they help protect the vast set of property interests that standard IP does not cover. The four main categories of IP—trade secrets, patents, trademarks, and copyrights—do not fully cover commercial, scientific, and technological creations. IP is subject to challenges of validity and imperfect enforcement against infringement.[27] Additionally, IP typically has significant registration requirements in comparison to tangible property.[28] USPTO patent and trademark applications must satisfy various regulatory criteria, which entail substantial legal costs in addition to the filing fees.[29] The U.S. Copyright Office registers copyrights subject to various restrictions on types of works of authorship and subject matter.[30]

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25. *See* Daniel A. Crane, *Intellectual Liability*, 88 TEX. L. REV. 253, 254 (2009) ("Innovation incentives, once protected by property rights, are increasingly being protected by liability rights.").

26. *See* Spulber, *supra* note 18.

27. John C. Paul et al., *Courts May Enforce Covenants Not to Challenge the Validity of Licensed Patents Contained in a License Agreement Settling Litigation When the Parties Clearly Waived Future Challenges to Validity*, FINNEGAN (Oct. 23, 2012), https://www.finnegan.com/en/insights/courts-may-enforce-covenants-not-to-challenge-the-validity-of.html.

28. F. Scott Kieff, *The Case for Registering Patents and the Law and Economics of Present Patent-Obtaining Rules*, 45 B.C. L. REV. 55, 123 (2003) ("The case for an alternative model registration system also is helpful in showing why increased scrutiny of patent applications would worsen, not improve, the present system's performance.").

29. Gene Quinn, *The Cost of Obtaining a Patent in the U.S.*, IPWATCHDOG (Apr. 4, 2015), http://www.ipwatchdog.com/2015/04/04/the-cost-of-obtaining-a-patent-in-the-us/id=56485/; *see* Rebecca Tushnet, *Registering Disagreement: Registration in Modern American Trademark Law*, 130 HARV. L. REV. 867 (2017).

30. *See* 17 U.S.C. § 102 (2018).

Second, ICs remedy problems of exclusion of access to intangible assets because ICs help determine how parties will share the returns and control over intangible assets. Without contracts, it can be difficult to protect intangible assets. The law treats tangible and intangible property differently because IP limits exclusivity, transferability, and duration of ownership.[31] Various court cases, statutes, and administrative decisions have weakened legal protections for IP. Although the Patent Act gives patents "the attributes of personal property," these protections are incomplete.[32] The Supreme Court ruled unanimously in *eBay Inc. v. MercExchange, L.L.C.* that "the creation of a right is distinct from the provision of remedies for violations of that right."[33] Physical barriers provide limited protection because knowledge is readily transferable and easy to imitate or appropriate. Secrecy may not be feasible because offering IP for sale or license requires disclosing the knowledge. Using IP within an organization and with business partners also requires continual sharing of knowledge.

Third, ICs handle non-rivalrous usage of intangible assets, a problem that generally does not arise with tangible assets. Intangible assets can provide services to multiple users at once.[34] ICs such as license and cross-license agreements provide access to intangible assets for multiple users and handle in-kind exchanges of access to intangible assets. ICs can bundle intangible assets such as licenses for patent portfolios, as well as bundle intangible assets with tangible assets, goods, and services. ICs also can unbundle intangible assets by specifying conditions of use through the grant of rights.

Fourth, ICs address problems in designing incentives for what I refer to here as "exploratory performance." An IC must monitor and reward the agent's performance in exploring uncharted waters. By its very nature, technological change is a leap into the unknown. Economic analysis identifies agency costs that arise from difficulties in observing an agent's hidden actions or hidden information.[35] Contracts must be based on performance because outputs are observable and verifiable while inputs are not. The design of an IC, however, encounters difficulties in determining performance targets and observing performance. It is hard

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31. Peter S. Menell, *The Property Rights Movement's Embrace of Intellectual Property: True Love or Doomed Relationship*, 34 ECOLOGY L. Q. 713, 747 (2007); Peter S. Menell, *Intellectual Property and the Property Rights Movement*, 30 REG. 36, 39 (2007).

32. *See* 35 U.S.C. § 261 (2018).

33. eBay Inc. v. MercExchange, L.L.C., 547 U.S. 388, 392 (2006).

34. There is non-rivalrous usage of some types of tangible assets if demand is constrained below the capacity of the asset. For example, there is non-rivalrous usage of a bridge or a park if demand is less than capacity and there are no congestion externalities. *See* Chizoba Mora, *How Is Computer Software Classified as an Asset?*, INVESTOPEDIA (May 15, 2018, 11:50 AM), https://www.investopedia.com/ask/answers/09/computer-software-intangible-asset.asp.

35. Epstein, *supra* note 10, at 6.

to know what the outcomes of invention, innovation, and technology adoption will be. This presents a greater challenge than traditional agency costs. This also makes it difficult to determine the intent of the parties as well as to find remedies for breach of contract. ICs provide incentives for exploration by rewarding measures of performance that are observable and verifiable rather than inventive effort.

Fifth, ICs provide mechanisms for addressing fundamental uncertainty associated with invention, innovation, and adoption. Technological change involves particular types of statistical, discovery, creativity, and market uncertainty. This uncertainty distinguishes ICs from standard contracts involving routine activities and risky investments in tangible assets. Fundamental uncertainty generates benefits from contingent contracting.[36] An IC must address the well-known trade-off between the benefits and costs of contingent contracts.[37] Contract law and the costs of contracting provide incentives for simple contract forms.[38] ICs offer basic mechanisms such as royalties and options that address the uncertainties of technological change.[39]

I identify five main types of ICs: employment, outsourcing, joint venture and consortium, license, and platform. Firms enter into employment contracts with scientific and technical personnel who conduct invention and innovation within the firm. Firms use outsourcing contracts with specialist firms and supply chain management companies that develop inventions and innovations. Firms form joint venture and consortium contracts to establish research joint ventures (RJVs) and R&D consortia. Joint venture and consortium contracts allow firms to share the costs, risks, and outputs of invention and innovation. Firms create license contracts for usage of patents, trademarks, copyrights, and business knowledge. Finally, firms apply platform contracts that bring together providers and adopters of technology. Firms enter into platform contracts with for-profit intermediaries and with cooperative institutions such as patent pools and other Collective Rights Organizations (CROs).[40]

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36. *Id.* at 10.

37. *Id.* at 8.

38. Alan Schwartz & Joel Watson, *The Law and Economics of Costly Contracting* 2–31 (John M. Olin Center for Stud. In L., Econ., & Pub. Pol'y, Working Paper No. 264, 2001) ("Contract law encourages courts to search thoroughly for the parties' actual intentions in creating the contract and in renegotiating it. We show that this search has yielded mandatory legal rules that make it extremely difficult for parties to restrict renegotiation, and that can increase greatly the cost of creating sophisticated contracts. As a consequence, parties now have legal incentives to use the more simple contract forms . . . ").

39. Joaquin Poblete & Daniel Spulber, *Managing Innovation: Optimal Incentive Contracts for Delegated R&D with Double Moral Hazard*, 95 EUR. ECON. REV. 38 (June 2017).

40. Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 CAL. L. REV. 1293, 1358 (1996).

I. INTELLECTUAL LAW

Developing the Intellectual Law framework requires a coherent treatment of invention, innovation, and technology adoption. However, legal protections for intangible assets are a mixture of property and tort. Applications of property and tort to intangible assets fail to address consent in a consistent way. As a consequence, these protections fail to perform effectively both property and tort functions. Recognizing the widespread use of various forms of ICs would help bring consistency to Intellectual Law because it addresses the key question of consent for agreements involving intangible assets. Courts can apply ICs to improve legal protections for the creation and application of intangible assets.

A. *The Conflict Between IT and IP*

Guido Calabresi and Douglas Melamed distinguish between property and tort in terms of who has consent.[41] Protections are based on property if the owner's consent to sell is necessary for transfers.[42] Protections are based on tort if the taker's consent to buy is sufficient for transfers.[43] This is because someone taking the asset determines whether they want to pay compensation by choosing to infringe. The liability rule effectively removes the owner's consent to sell, whether or not the taking is intentional.[44] The distinction between property and tort rules provides clarity for tangible assets that may be absent for intangible assets.

Legal protections for intangible assets—currently based on a haphazard combination of IT and IP—are incomplete because they do not address consent in a consistent way. Protections for intangible assets are based partly on IT because damage remedies remove the IP owner's consent to sell an intangible asset. Damage remedies make the infringer's consent to buy sufficient for ongoing transfers. Based on this perspective, some have characterized patent infringement as a "strict liability" tort.[45]

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41. Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules and Inalienability: One View of the Cathedral*, 85 HARV. L. REV. 1089, 1092 (1972) ("An entitlement is protected by a property rule to the extent that someone who wishes to remove the entitlement from its holder must buy it from him in a voluntary transaction in which the value of the entitlement is agreed upon by the seller. . . . Whenever someone may destroy the initial entitlement if he is willing to pay an objectively determined value for it, an entitlement is protected by a liability rule. This value may be what it is thought the original holder of the entitlement would have sold it for.").

42. *Id.*

43. *Id.*

44. Richard A. Epstein, *The Clear View of the Cathedral: The Dominance of Property Rules*, 106 YALE L.J. 2091, 2091 (1997) ("[A] liability rule denies the holder of the asset the power to exclude others or, indeed, to keep the asset for himself.").

45. Mark A. Lemley, *Should Patent Infringement Require Proof of Copying?*, 105 MICH. L. REV. 1525, 1525 (2006) ("Patent infringement is a strict liability offense."); Roger Blair &

Following this approach to patent infringement, various limitations on strict liability would further reduce protections for inventions.[46] Protections for intangible assets are based partly on IP because the IP owner has some rights to exclude and so must consent to license or sell an intangible asset.[47] However, IP rights often limit exclusivity, again removing the IP owner's consent to sell.[48]

The Supreme Court's unanimous *eBay* decision illustrates the mixture of property and tort approaches.[49] Problems arise because the Court did not address *consent* in a consistent way. The *eBay* decision has created some confusion by conflating IT and IP.[50] The Court in *eBay* weakens IP in comparison to tangible property by reducing the consent of the IP owner as seller.[51] The infringer's consent as buyer can dominate the IP owner's consent as seller, converting property remedies to tort remedies.

The *eBay* decision limits injunctions for intangible assets by applying the four-factor test for issuing injunctions to patent infringement.[52] The first factor, irreparable harm, is a particularly high hurdle for the IP owner. Second, requiring the IP owner to show that remedies are inadequate compensation is an additional burden that replaces IP with IT rules. Third, consideration of the balance of hardships between plaintiff and defendant differs substantially from property rights in tangible assets. Consideration of the balance of hardships combines the IP owner's consent as seller with the infringer's consent as buyer. Finally, the public interest criterion places IP rights in a different category from tangible property.

Thomas F. Cotter, *Strict Liability and Its Alternatives in Patent Law*, 17 BERKELEY TECH. L.J. 799, 800 (2002) [hereinafter Blair & Cotter, *Strict Liability*] ("Patent infringement is a strict liability tort in the sense that a defendant may be liable without having had any notice, prior to the filing of an infringement action, that her conduct was infringing."); Roger Blair & Thomas F. Cotter, *An Economic Analysis of Damages Rules in Intellectual Property Law*, 39 WM. & MARY L. REV. 1585 (1998).

46. Blair & Cotter, *Strict Liability*, *supra* note 45, at 806 (suggesting that liability need not be considered strict because in some cases giving notice is required for liability).

47. *Id.*

48. *Id.*

49. eBay Inc. v. MercExchange, L.L.C., 547 U.S. 388 (2006).

50. *See id.*

51. *See id.*

52. *See id.* at 388, 393 ("The traditional four-factor test applied by courts of equity when considering whether to award permanent injunctive relief to a prevailing plaintiff applies to disputes arising under the Patent Act. That test requires a plaintiff to demonstrate: (1) that it has suffered an irreparable injury; (2) that remedies available at law are inadequate to compensate for that injury; (3) that considering the balance of hardships between the plaintiff and defendant, a remedy in equity is warranted; and (4) that the public interest would not be disserved by a permanent injunction. . . . [A] permanent injunction will issue once infringement and validity have been adjudged.").

Andrew Beckerman-Rodau observes that *eBay* is "part of a broad attack on the current U.S. patent system."[53] David McGowan argues that the Court in *eBay* "reversed the longstanding presumption in favor of permanent injunctive relief for proven patent infringement."[54] Evidence suggests that post-*eBay* district courts continue to grant permanent injunctions.[55] Injunctions are more likely when the IP owner competes with the infringer.[56]

Richard Epstein argues against exclusively using damages for infringement of IP in the absence of the possibility of injunctive relief.[57] Infringement would then function as a viable option for the infringer, potentially leading to excessive infringement.[58] Epstein compares damages for infringement to the general problem of damages for breach of contract.[59] He criticizes the "efficient breach" approach when expectation damages are the only remedy for breach of contract.[60] Without the possibility of injunctive relief, expectation damages function as an option for the party contemplating breach, which may reduce incentives to contract.[61]

The courts' standard approach to resolving patent infringement disputes further illustrates the mixture of property and tort. Courts typically apply the "hypothetical negotiation" approach to calculating reasonable royalty damages.[62] The hypothetical negotiation approach combines property and tort because it tries to imagine both what a willing licensor would accept and what a willing licensee would accept.[63] The

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53. Andrew Beckerman-Rodau, *The Supreme Court Engages in Judicial Activism in Interpreting the Patent Law in eBay, Inc. v. MercExchange, L.L.C.*, 10 TUL. J. TECH. & INTELL. PROP. 165, 165 (2007).

54. David McGowan, *Irreparable Harm*, 14 LEWIS & CLARK L. REV. 577, 579 (2010).

55. *See* Rachel M. Janutis, *The Supreme Court's Unremarkable Decision in eBay Inc. v. MercExchange, L.L.C.*, 14 LEWIS & CLARK L. REV. 597, 601, 604 (2010); Benjamin Peterson, *Injunctive Relief in the Post-eBay World*, 23 BERKELEY TECH. L. J. 193, 196 (2008); Douglas Ellis et al., *The Economic Implications (and Uncertainties) of Obtaining Permanent Injunctive Relief After eBay v. MercExchange*, 17 FED. CIR. B. J. 437, 441 (2008).

56. Janutis, *supra* note 55, at 605.

57. Epstein, *supra* note 10, at 5.

58. *Id.* at 24.

59. *Id.* at 6–8.

59. *Id.*

61. *Id.* at 24–25.

62. John C. Jarosz & Michael J. Chapman, *The Hypothetical Negotiation and Reasonable Royalty Damages: The Tail Wagging the Dog*, 16 STAN. TECH. L. REV. 769, 772 (2013) ("[T]he hypothetical negotiation construct was originally introduced simply as one of many considerations to estimate such damages. It has since evolved into the primary tool used to determine reasonable royalty damages.").

63. Georgia-Pacific Corp. v. U.S. Plywood Corp., 318 F. Supp. 1116, 1121 (S.D.N.Y. 1970) ("The [willing buyer and willing seller] rule is more a statement of approach than a tool of analysis. It requires consideration not only of the amount that a willing licensee would have paid for the patent license but also of the amount that a willing licensor would have accepted.").

acceptance of the willing licensor is the property side of the law and the acceptance of the willing licensee is the tort side of the law. So, the hypothetical negotiation tries to simultaneously satisfy property and tort remedies.

The hypothetical negotiation, however, may fail to satisfy both property and tort remedies. One reason for this is that the hypothetical benefit to the infringer may be less than the hypothetical harm to the patent holder. If the infringer's benefit from adopting the technology is less than the patent holder's cost of providing the technology, there is no basis for an economically efficient transaction. The transaction would yield negative net benefits.

If the infringer's benefit from adopting the technology is less than the cost to the patent holder of providing the technology, there is no royalty that would support an exchange. The patent holder would not give consent as seller for any royalty that does not cover the cost of providing the technology because the royalty would not be compensatory. So, the hypothetical negotiation would not protect property interests.

Conversely, the infringer would not consent as buyer to any royalty that would be greater than the benefits of implementing the technology. The patent holder thus would not be compensated for the damages from infringement. So, the hypothetical negotiation would not satisfy tort requirements.

Further, the hypothetical negotiation also fails to provide either property or tort remedies because it undertakes the impossible task of determining the property owner's expectations and the infringer's expectations before infringement occurs.[64] This requires knowledge not available to either the patent holder or the infringer, let alone the court. The passage of time and the resolution of uncertainty will change the infringer's benefit from infringement and the patent holder's damages from infringement. Damages based on the hypothetical negotiation are unlikely to reflect either the patent holder's cost as seller or the infringer's benefit as buyer.

The courts apply two damages calculations that are subject to similar problems.[65] First, the "bottom-up" approach calculates reasonable royalty damages as a share of the infringer's benefit based on the incremental value of the patents to the infringer.[66] This approach requires not only determining the infringer's direct valuation of the patented technology,

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64. *Id.*

65. *Id.*

66. Gregory K. Leonard & Mario A. Lopez, *Determining RAND Royalty Rates for Standard-Essential Patents*, 29 ANTITRUST 86, 88 (2014) ("The bottom-up approach is consistent with the conceptual definition of RAND and is commonly performed in patent infringement cases.").

but also the valuation of the best alternative.[67] Second, the "top-down" approach is based on marking down the infringer's profit and apportioning that profit among multiple technologies.[68] The top-down approach appears in *In re Innovatio* and *TCL Communications v. Ericsson*.[69]

Both of these damage calculations are based on the infringer's benefits.[70] The two methods represent tort solutions to patent infringement because they are sufficient to insure the infringer's consent as buyer for ongoing infringement. These methods may not necessarily be compensatory, however, because the awarded damages may be less than the patent holder's costs—even if the patent holder's costs are less than the infringer's benefits. These methods are a shift from IP to IT because they tend to remove the owner's consent as seller.

B. *Untangling IT and IP*

IC rules provide guidance in untangling IT and IP. Private agreements should be more efficient than outcomes created by courts because the parties know more about their situation than do the courts. Transaction costs can reduce the efficiency of private agreements, but such costs tend to be lower than litigation costs.

The courts can untangle IT from IP by separating compensation from injunction. An IC protects the expectations of the parties to the agreement. If an IC is breached, it is necessary to compensate the injured party for harm caused by the breach. The courts should at least provide compensation to owners of IP for infringement that has already occurred. The damages to IP owners should include all of the economic costs due to the infringement, including transaction costs. The damages also can be tripled if the infringer engaged in "egregious infringement behavior."[71]

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67. *Id.*

68. *Id.* at 89.

69. *In re* Innovatio IP Ventures, LLC Patent Litigation, No. 11-C-9308, 2013 WL 5593609 (N.D. Ill. Oct. 3, 2012); TCL Commc'ns Tech. Holdings, Ltd. v. Telefonaktenbologet LM Ericsson, No. SACV 14-00341 JVS (ANx), 2016 WL 4150033 (C.D. Cal. July 25, 2016); *see* Jason Rantanen, *TCL v. Ericsson: The First Major U.S. Top-Down FRAND Royalty Decision*, PATENTLYO (Dec. 27, 2017), https://patentlyo.com/patent/2017/12/contreras-ericsson-decision.html; Richard Vary, *Supersize This: Unwired Planet American Style*, BIRD & BIRD (Dec. 2017), https://www.twobirds.com/en/news/articles/2017/global/supersize-this-unwired-planet-american-style.

70. Leonard & Lopez, *supra* note 66, at 86–87.

71. *See* Halo Elecs. Inc. v. Pulse Elecs. Inc., 136 S. Ct. 1923, 1925 (2016); Stryker Corp. v. Zimmer, Inc., 782 F.3d 649, 661 (Fed. Cir. 2015); George W. Jordan III, *Halo v. Pulse: A New Chapter for Willfulness and Enhanced Patent Damages*, LANDSLIDE (Mar.–Apr. 2017), https://www.americanbar.org/groups/intellectual_property_law/publications/landslide/2016-17/march-april/halo_v_pulse_new_chapter_willfulness_and_enhanced_patent_damages/.

The courts should not necessarily rely on compensation for infringement that has not yet occurred. Forward-looking damages give the infringer consent as the buyer and remove the owner's consent as the seller. This approach weakens IP and leads to an inefficient appropriation of technology. Instead, courts should impose an injunction when necessary to prevent future infringement.[72] This restores the consent of the owner of the intangible asset.

An injunction not only mitigates future harm but provides incentives for the parties to negotiate an IC. If the benefit to the infringer is greater than the cost to the owner, the parties benefit from an IC; an injunction should thus lead to an IC. If the benefit to the infringer is less than the cost to the owner, then the parties will not benefit from an IC, but an injunction will stop the infringement. Injunctions protect the IP rights of the owners of the intangible assets by restoring their consent as seller.

Infringement is technology transfer in the absence of an IC. Infringement represents a failure to contract, whether or not infringement is intentional.[73] Failure to reach a contractual agreement combined with continued usage of the intangible asset is likely to lead to an infringement dispute. An IC prevents the infringement dispute and can also resolve an infringement dispute after it has already begun.

IC rules also help calculate damage remedies for infringement. Rather than imagining the situation of the parties before infringement began, it is necessary to determine the actual harm from infringement. As I discuss in detail elsewhere, the court in a patent case gathers evidence that fills in many of the terms of a patent license agreement.[74] The evidence includes the identity of the parties, their business relationship, and the nature of the IP being transferred. The evidence indicates the extent of the infringement and helps determine the harm to the owner of the intangible assets.

In infringement disputes, courts should construct what I have referred to elsewhere as an "informed contract."[75] This approach is consistent with IC rules and replaces the flawed hypothetical negotiation. The informed contract builds on the information revealed by the patent case to estimate the harm to the patent holder. The patent holder's lost profits and reasonable damages should be based on infringement that actually occurred. Courts should not attempt the impossible task of constructing imagined expectations for a negotiation that did not occur.

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72. 35 U.S.C. § 283 (2018) ("The several courts having jurisdiction of cases under this title may grant injunctions in accordance with the principles of equity to prevent the violation of any right secured by patent, on such terms as the court deems reasonable.").

73. Spulber, *supra* note 18, at 21.

74. Spulber, *supra* note 18, at 7.

75. Spulber, *supra* note 18, at 3.

In determining damages for infringement, the IC approach suggests that courts should use royalties from comparable ICs. These royalties from comparable license contracts should be adjusted based on information revealed by the patent case. In particular, royalties should reflect the increase in market value of a license that comes with a patent found to be valid and infringed upon. Royalties for Standard Essential Patents (SEPs) should reflect the added market value of the patent license that is revealed by inclusion of the patent in technology standards chosen by a Standard Setting Organization (SSO). Other characteristics of patents can raise or lower the market value of licenses and can be used to adjust royalties from comparable licenses.

If there are no comparable patent licenses, reasonable royalty damages can be estimated by using the market prices of patents. I have spelled out the "market value method" of calculating reasonable royalty damages.[76] The market prices of patents provide information about expected returns from own use and total royalties from multiple licensing agreements. These can be apportioned among infringers to determine the royalties that would have been received but for the infringement.

IT, or liability for infringement, does not offer sufficient legal support for technological change. IT does little to deter infringement of ideas and provides no guidelines for cooperative agreements. Technological change cannot depend only on compensating patent holders for infringement. Although recovery of lost profits or reasonable royalty damages may serve as remedies for infringement, this is not sufficient to induce cooperative investment in creating and applying new ideas. IP protections are necessary to preserve incentives to form ICs, thus protecting expectation interests.

C. *ICs and the "Market for Innovative Control"*

IC rules help resolve the ongoing debate over whether IP or IT provides the best protections for inventors. The protection of the interests of inventors depends on the combination of property, tort, and contract rules. ICs generate gains from trade for all parties, thus enhancing the benefits for inventors beyond what IP and IT protections can provide. ICs complement IP and IT protections by supporting commercialization and cooperative investment.

ICs are the main transaction method for what I have termed the "market for innovative control."[77] ICs allocate both returns from intangible assets and rights of control over innovation using those assets.

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76. Spulber, *supra* note 18, at 7 (describing the "market value method" of calculating reasonably royalty damages).

77. Daniel F. Spulber, *How Patents Provide the Foundation of the Market for Inventions*, 11 J. COMPETITION L. & ECON. 271, 274 (2015).

ICs protect the continual stream of discoveries and extensive sharing of knowledge required for cooperative investment. ICs involve investment in disembodied technology as well as technology embodied in goods and services. The characteristics of technological change suggest increased usage of ICs in comparison to standard contracts. Investment continues to shift away from tangible assets and toward intangible assets. Virtual inventions and innovations represent a shift away from hardware innovations and toward software innovations.[78] For example, improvements in products, production processes, and business methods may take the form of software upgrades rather than new equipment with improved capabilities. Such innovation will take the form of intangible assets. Technology transfers and upgrades will require ICs that protect expectation interests and IP.

Technological change that increases connectivity and knowledge sharing may require new types of contract provisions. Innovations in IoT involve a significant increase in connectivity among firms as well as between firms and customers. The International Telecommunications Union (ITU) defines the IoT as: "A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies."[79] According to the ITU, "The IoT is expected to greatly integrate leading technologies, such as technologies related to advanced machine-to-machine communication, autonomic networking, data mining and decision-making, security and privacy protection, and cloud computing, with technologies for advanced sensing and actuation."[80] The ITU identifies various types of business roles in IoT, including providers of platforms, networks, devices, and applications.[81] These business roles are likely to require ICs.

Advances in AI also suggest greater use of ICs. Employees and managers working with AI will jointly generate knowledge and inventions. It will be necessary to specify how to monitor and reward the performance of employees and managers who interact with AI systems. It will also be necessary to determine inventions and innovations created by employees that work with AI systems. Related considerations apply to contractual relationships between firms that involve AI systems. It may be necessary to specify performance in terms of both the activities of individuals and AI systems.

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78. MÉNIÉRE ET AL., *supra* note 1, at 20.

79. INT'L TELECOMM. UNION, SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS (June 2012), https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-Y.2060-201206-I!!PDF-E&type=items.

80. *Id*. at 2.

81. *Id*. at 4.

The market for innovative control depends on the broad framework of Intellectual Law. Protections for IP rights and other aspects of IP improve the efficiency of transactions in the market for innovative control.[82] Extending and enhancing these traditional protections, ICs allocate residual returns and residual control rights from IP and support cooperative investment in invention, innovation, and adoption. ICs are important for innovation by established firms and entrepreneurs because they protect the expectation interests of inventors, innovators, and adopters. ICs thus support cooperative agreements to develop and apply technology. These agreements increase the benefits of inventors beyond what they could obtain through own use and transfers of inventions. So, ICs promote the interests of inventors beyond what property or liability rules alone could achieve.

Efficient economic activity depends on a combination of contractual agreements and property rights. Contractual agreements require well-defined property rights for tangible assets that provide completeness, exclusivity, and transferability. In turn, owners of tangible property, including land, structures, inventory, and capital equipment, cannot realize the full economic value of those assets simply from own use and transfer of assets to others. Property owners need contracts that support cooperation over time and investment in tangible assets. A market system requires contracts for employment, production, construction, procurement, distribution, and finance.

Technological change also depends on a combination of contractual agreements and property rights. IP provides the foundation of the market for innovative control by improving efficiency and gains from trade from ICs. However, even a well-functioning IP system is not sufficient to protect the interests of inventors, innovators, and adopters. Owners of IP cannot rely only on own-use and transfers of IP. ICs allocate both residual returns and residual rights of control over how inventions are developed and applied to generate innovations. Through ICs such as licensing agreements, patent holders and technology adopters determine how technology will be applied. Firms require ICs to form agreements with employees, suppliers, partners, distributors, investors, and customers.

ICs differ from standard contracts because the characteristics of intangible assets differ from those of tangible assets. Firms form ICs with managers and specialized employees to carry out invention, innovation, and adoption. Firms form ICs with other firms to outsource R&D and to share inventions and innovations. The development and application of inventions and innovations require cooperative investment to create and develop intangible assets. ICs realize many benefits that are beyond the reach of own use or immediate exchange of intangible assets.

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82. Spulber, *supra* note 77.

An IC involves those intangible assets associated with invention, innovation, and adoption. Not all intangible assets are related to technological change.[83] According to the International Accounting Standards (IAS) 38, "An intangible asset is an identifiable non-monetary asset without physical substance. Such an asset is identifiable when it is separable, or when it arises from contractual or other legal rights. Separable assets can be sold, transferred, licensed, etc."[84] The legal rights and obligations in a contract also are intangible assets, but not all contracts are ICs.[85]

The market for innovative control allocates both returns of innovation and control over innovative investment decisions. The market for technology resembles the stock market, which allocates both residual returns and residual rights of control over corporate investment decisions. The market for innovative control includes licensing and cross-licensing agreements for IP and specialized agreements to develop and apply inventions and innovations over time. The market for innovative control also includes the transfer of intangible assets and the sale of inventions and innovations that are embodied in goods and services. The market for innovative control further includes mergers and acquisitions (M&A) that transfer ownership of corporations' intangible assets. The market for innovative control also encompasses financing of invention and innovation, including venture capital.[86]

Despite its limitations, IP improves transaction efficiencies in the market for innovative control. In addition to exclusivity and transferability, IP reduces transaction costs and improves the efficiency of contracts by offering disclosure, certification, standardization, and divisibility.[87] IP provides a basis for licensing, cross-licensing, and other

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83. *IAS 38—Intangible Assets*, DELOITTE, https://www.iasplus.com/en/standards/ias/ias38 (last visited Feb. 9, 2019) (Examples of intangible assets include: "[P]atented technology, computer software, databases and trade secrets; trademarks, trade dress, newspaper mastheads, internet domains; video and audiovisual material (e.g. motion pictures, television programmes); customer lists; mortgage servicing rights; licensing, royalty and standstill agreements; import quotas; franchise agreements; customer and supplier relationships (including customer lists); marketing rights.").

84. *IAS 38 Intangible Assets*, INT'L FIN. REPORTING STANDARDS FOUND., https://www.ifrs.org/issued-standards/list-of-standards/ias-38-intangible-assets/ (last visited Feb. 9, 2019).

85. Robert F. Reilly, *Valuation of Contract-Related Intangible Assets*, THE PRACTICAL LAWYER, Dec. 2013, at 37, 38, http://www.willamette.com/pubs/presentations3/reilly_contract_intangibles_tpl2013.pdf ("The contract document (or the oral agreement) itself is not the intangible asset. The legal rights and duties of the contract are the intangible asset.").

86. *See* DANIEL F. SPULBER, THE INNOVATIVE ENTREPRENEUR 27–29 (2014).

87. Daniel F. Spulber, *Public Prizes Versus Market Prices: Should Contests Replace Patents?*, 97 J PAT. & TRADEMARK OFF. SOC'Y 690 (2015).

ICs. IP supports ICs involving the joint development and allocation of inventions and innovations.

Robert Merges emphasizes the general contributions of property to contracting, and these contributions are particularly applicable to IP.[88] Merges points out that property provides "precontractual liability," which protects the disclosure of information before a contract is formed.[89] Merges further observes that property provides "enforcement flexibility" after a contract is formed.[90] Merges emphasizes the importance of this interaction between contract and property with modular production and specialized firms.[91]

IP enhances coordination in contractual relationships. Scott Kieff emphasizes that patents "facilitate investment in the complex, costly, and risky commercialization activities required to turn nascent inventions into new goods and services."[92] Kieff observes that "This commercialization approach sees property rights in IP serving a role akin to beacons in the dark, drawing to themselves all of those potential complementary users of the IP-protected-asset to interact with the IP owner and each other."[93] Kieff argues that the coordination provided by IP leads to contracts: "This helps them each explore through the bargaining process the possibility of striking contracts with each other."[94]

IP generates economic benefits by supporting market transactions rather than simply own use of intangible assets. A report by the Economics and Statistics Administration and the USPTO frames the benefits of IP in terms of economic activities:

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88. Robert P. Merges, *A Transactional View of Property Rights*, 20 BERKELEY TECH. L.J. 1477 (2005).

89. *Id.* at 1488.

90. *Id.*

91. *Id.* at 1514–19.

92. F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. REV. 697, 703 (2000); *see also* Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 266 (1977); John F. Duffy, *Rethinking the Prospect Theory of Patents*, 71 U. CHI. L. REV. 439, 439 (2004); Paul J. Heald, *A Transaction Costs Theory of Patent Law*, 66 OHIO ST. L.J. 473, 508 (2005).

93. Email from the Honorable F. Scott Kieff, Comm'r, U.S. Int'l Trade Comm'n, to U.S. Fed. Trade Comm'n & Dep't of Justice, (Sept. 23, 2016) [hereinafter Kieff, FTC & DoJ Joint IP-AT Guidelines Email], https://www.ftc.gov/policy/public-comments/2016/09/30/comment-00006 (expressing his views on the United States Federal Trade Commission's and the United States Department of Justice Antitrust Division's Joint Guidelines for the Licensing of Intellectual Property); *see also* F. Scott Kieff & Troy A. Paredes, *The Basics Matter: At the Periphery of Intellectual Property*, 73 GEO. WASH. L. REV. 174, 179 (2004).

94. Kieff, FTC & DoJ Joint IP-AT Guidelines Email, *supra* note 93.

- Providing incentives to invent and create;
- Protecting innovators from unauthorized copying;
- Facilitating vertical specialization in technology markets;
- Creating a platform for financial investments in innovation;
- Supporting entrepreneurial liquidity through mergers, acquisitions, and IPOs;
- Supporting licensing-based technology business models; and
- Enabling a more efficient market for trading in technology and know-how.[95]

Notice that each of these economic activities is based on parties forming ICs, including invention, innovation, finance, licensing, and transactions in the market for technology.

Conversely, IP owners rely on ICs for the development, commercialization, and application of intangible assets. The increasing importance of technological change in the economy has generated a burgeoning market for innovative control.[96] Owners of intangible assets not only obtain a stream of returns, but also have rights of control over inventions, innovations, and adoption. The market value of intangible assets is the present value of the stream of returns and control rights.

IC relationships provide mechanisms of commercialization for IP holders. Raymond Nimmer points out that "commercialization, which depends on contractual relationships, constitutes one of the core mechanisms by which information is developed and distributed. It is a central part of intellectual property law 'bargain' and should be recognized as such."[97] Nimmer observes: "Only the most naive observer, or one with a clear political agenda, can look at the intellectual property laws and their history and suggest that policy in the property sphere trumps or precludes the influence of contract."[98] For example, contracts

95. JUSTIN ANTONIPILLAI & MICHELLE K. LEE, USPTO, INTELLECTUAL PROPERTY AND THE U.S. ECONOMY: 2016 UPDATE 3 (last visited Mar. 28, 2018), https://www.uspto.gov/sites/default/files/documents/IPandtheUSEconomySept2016.pdf.

96. Spulber, *supra* note 77, at 6.

97. Raymond T. Nimmer, *Breaking Barriers: The Relation Between Contract and Intellectual Property Law*, 13 BERKELEY TECH. L.J. 827, 888 (1998). Nimmer also states that "property rights are routinely transferred, waived, released and licensed. Contracts provide the means for the development and commercial exploitation of information assets." *Id.* at 830.

98. *Id*. at 827.

such as online "click-wrap" agreements provide "private ordering" for information and knowledge sharing.[99]

Because antitrust policy generally targets anti-competitive conduct rather than ownership rights, antitrust policy toward innovation correspondingly targets anti-competitive conduct rather than ownership of intangible assets. The Department of Justice (DOJ) Antitrust Division and the Federal Trade Commission (FTC) both recognize that IP owners depend on contracts to realize the benefits from intangible assets.[100] The title of the DOJ and FTC policy thus addresses a type of IC rather than IP: "Antitrust Guidelines for the Licensing of Intellectual Property."[101] Further, the Antitrust Guidelines acknowledge the central importance of contracts when dealing with IP: "The owner of intellectual property has to arrange for its combination with other necessary factors to realize its commercial value."[102]

ICs and IP perform different economic functions, although both have present values. An IC can be described as a joint investment project that generates a stream of returns over time and is subject to uncertainty. An immediate exchange of IP involves the transfer of a bundle of rights that generates a stream of returns over time that is subject to uncertainty. In both cases, the stream of returns over time refers to the stream of revenues minus costs at each date.

An IC provides a mechanism for cooperation over time to implement technological change. An IC spells out the performance of activities involved in technological change. Adjusting investment over time in light of new information increases the expected value of investment projects in comparison to projects that do not adjust investment levels.[103]

As with contracts generally, an IC protects the expectation interests of the parties and provides incentives for investment. Because contracts are voluntary, the parties only enter into an IC if they anticipate benefits from

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99. *See* Sharon K. Sandeen, *A Contract by Any Other Name Is Still a Contract: Examining the Effectiveness of Trade Secret Clauses to Protect Databases*, 45 IDEA 119, 122 (2005) (discussing the relationship between contracts and IP); David Friedman, *In Defense of Private Orderings: Comments on Julie Cohen's Copyright and the Jurisprudence of Self-Help*, 13 BERKELEY TECH. L.J. 1151, 1152 (1998); J. H. Reichman & Jonathan A. Franklin, *Privately Legislated Intellectual Property Rights: Reconciling Freedom of Contract with Public Good Uses of Information*, 147 U. PA. L. REV. 875, 904 (1999); Robert P. Merges, *The End of Friction? Property Rights and Contract in the "Newtonian" World of On-Line Commerce*, 12 BERKELEY TECH. L.J. 115, 126 (1997).

100. FED. TRADE COMM'N, ANTITRUST GUIDELINES FOR THE LICENSING OF INTELLECTUAL PROPERTY 4 (Jan. 12, 2017), https://www.ftc.gov/system/files/documents/public_statements/1049793/ip_guidelines_2017.pdf.

101. *Id.*

102. *Id.*

103. *See, e.g.,* AVINASH K. DIXIT & ROBERT S. PINDYCK, INVESTMENT UNDER UNCERTAINTY 2 (1994).

the bargain. To benefit from the bargain, both parties must receive gains from trade. The terms of the contract allocate gains from trade and define future performance.

The parties' expectation interests refer to the anticipation of benefits in the future. A contract protects a party's expectation interests if the party realizes the value of the contract, even if the promised performance does not occur. The legal use of the term "expectation" refers to the parties' present value of future benefits from the contract. However, this can differ from the use of the term "expectation" in the fields of probability and statistics.

The present value of a contract depends on the discount rate and expectations about uncertain outcomes. In the absence of uncertainty, the total benefits of an IC equal the present value of the stream of future returns discounted using the appropriate rate of interest. The parties to an IC will divide the present discounted value of the stream of future returns. The benefits of owning IP also equal the present discounted value of the stream of future returns obtained by using and licensing the IP. In a competitive market, the price of the IP should equal the present discounted value of the stream of future returns. When uncertainty is present, estimating the benefits of an IC and the benefits of owning IP involve expectations about the resolution of uncertainty. Combined, the discounting of future benefits and the expectation of the outcome of uncertainty generate an expected present discounted value.[104]

An IC enhances the value of IP because cooperation generates gains from trade. The parties create additional economic value relative to own-use or an immediate exchange of intangible assets. An IC protects the expectation interests of both parties. Let V denote the present value of the discounted stream of net benefits expected by parties forming an IC. Let U denote the total opportunity costs of the parties, which equals the present value of the discounted stream of expected benefits forgone. Then, $V – U$ denotes total gains from trade for the two parties entering an IC.

Licensing agreements are a form of IC covering the usage of all types of intangible assets: patents, trademarks, copyrights, and trade secrets. Suppose that V is the net benefit of the licensee and suppose also that the IP holder derives no additional benefits from the agreement. The benefit V includes the returns to investment by the licensee in applying the technology and returns to investment in complementary assets net of the costs of investment. Suppose that the licensee has no opportunity costs

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104. There are difficulties in forming expectations about future events. *See* discussion *infra* Section IV. Also, calculating the expected present discounted value of a stream of benefits requires adjusting either discount rates or the expected value of benefits to account for the costs of risk. *See* Alexander A. Robichek & Stewart C. Myers, *Conceptual Problems in the Use of Risk-Adjusted Discount Rates*, 21 J. FIN. 727, 727–30 (1966).

and U is the opportunity cost of the IP owner. The licensee pays compensation R that represents the present value of the expected stream of royalty payments to the IP owner, which is less than the benefit of the licensee and greater than the opportunity cost to the IP owner. License royalties divide gains from trade $V - U$.

Expectation damages for breach of a patent license contract are based on the royalties that the licensor would have received had the contract been honored by the licensee. Expectation damages for breach of contract generally protect the plaintiff's expectation.[105] Economic analysis suggests that expectation damages for breach of contract generate efficient performance decisions and also induce efficient reliance investment.[106]

By protecting expectation interests, an IC provides incentives to invest efficiently in invention, innovation, and adoption. Expectation damages provide incentives for efficient investment in developing the invention and in complementary assets as well. This is because parties choose investment levels that maximize expected returns net of the costs of investment. Maximization of expected returns net of the costs of investment means that investment is chosen such that the expected marginal return to investment equals the marginal cost of investment. With only partial protections for expectation interests, a party to the contract may not receive all of the expected returns to investment. This implies that a party to the contract may not receive the expected marginal returns to additional investment. This provides incentives for a contracting party to choose an amount of investment below the efficient level. Consequently, a contracting party would not choose an amount of investment that maximizes expected returns net of the costs of investment. So, protection of expectation interests is necessary for parties to obtain the greatest possible gains from trade. ICs thus provide dynamic

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105. *See* Charles J. Goetz & Robert E. Scott, *Liquidated Damages, Penalties and the Just Compensation Principle: Some Notes on an Enforcement Model and a Theory of Efficient Breach*, 77 COLUM. L. REV. 554, 562 n.32 (1977); Ian R. Macneil, *Contracts: Adjustment of Long-Term Economic Relations Under Classical, Neoclassical, and Relational Contract Law*, 72 NW. U. L. REV. 854, 864 n.31 (1978); Anthony T. Kronman, *Specific Performance*, 45 U. CHI. L. REV. 351, 352 (1978); Alan Schwartz, *The Case for Specific Performance*, 89 YALE L.J. 271, 271 (1979); Richard Craswell, *Contract Remedies, Renegotiation, and the Theory of Efficient Breach*, 61 S. CAL. L. REV. 629, 630 (1988).

106. *See* E. Allan Farnsworth, *Legal Remedies for Breach of Contract*, 70 COLUM. L. REV. 1145, 1147 (1970); John H. Barton, *The Economic Basis of Damages for Breach of Contract*, 1 J. LEGAL STUD. 277, 278 (1972); Robert L. Birmingham, *Breach of Contract, Damage Measures, and Economic Efficiency*, 24 RUTGERS L. REV. 273, 286 (1970); Lewis A. Kornhauser, *An Introduction to the Economic Analysis of Contract Remedies*, 57 U. COLO. L. REV. 683, 720–21 (1986); William P. Rogerson, *Efficient Reliance and Damage Measures for Breach of Contract*, 15 RAND J. ECON. 39, 44 (1984).

efficiencies that protect and increase benefits to inventors, innovators, and adopters.

IC rules are consistent with property protections for intangible assets. There are two main forms of legal protection for patent holders. Federal law protects the patent holder from infringement of IP rights by enforcing exclusion.[107] State law protects patent holders from infringement that results from breach of contract.[108] Phillip Jones points out that "the licensor may have the option to seek a remedy for a license restriction breach under the contract or from a patent infringement suit."[109] Jones concludes that "[i]n fact, a licensor may be able to obtain the same range of remedies in state court for the breach of a license agreement that the licensor would be able to obtain in federal court for patent infringement under 35 U.S.C. §§ 283–85 (i.e., an injunction, compensatory damages, and attorney fees)."[110]

To illustrate how expectation damages affect breach decisions in patent license contracts, suppose that a licensor expects to receive a payment of R from the licensing agreement. For ease of discussion, suppose that the licensor does not have any lost profits and does not incur any licensing costs, although the discussion can readily be generalized without changing the conclusions. Expectation damages for a licensee breach of contract restore the licensor to the position he would be if the contract had been honored. This implies that damages D equal the payment R that the licensor would have received.

The damages remedy affects the licensee's contract breach decision. Suppose that after the licensing contract is signed, the licensee develops an alternative invention that generates net benefits Z. Alternatively, Z could represent the market value of a new alternative invention net of royalty payments. The licensee will breach the contract if and only if the benefits of switching to the alternative technology net of switching costs and contract damages are greater than the net benefits of honoring the contract. This means that breach occurs if and only if the benefits of adopting the new technology net of damages $Z - D$ are greater than the benefits $V - R$ of the patented technology net of royalties.

Expectation damages equal the payment that the licensor expected to receive. Netting out the damage payment and the corresponding royalty payment, this implies that breach occurs if and only if the value Z obtained from applying the alternative technology is greater than the value V from the patented invention. This means that with expectation

107. 35 U.S.C. § 154 (2018).

108. Phillip B.C. Jones, *Violation of a Patent License Restriction: Breach of Contract or Patent Infringement?*, 33 IDEA: J.L. & TECH. 225, 226 (1993) ("[A] patent licensing agreement is a contract which is governed by principles of state contract law.").

109. *Id.*

110. *Id.* at 240, n.75.

damages, breach of the licensing contract should occur if and only if breach is efficient, that is, if *Z* is greater than *V*. So, expectation damages for breach of licensing agreements provide incentives for efficient technology adoption decisions.

When expectation damages are sufficient to protect the expectation interests of the parties, the parties choose the terms of the agreement to maximize the present value of expected benefits. Also, the parties choose their investments to maximize the present value of total expected benefits. In this way, an IC increases the benefits of IP owners in comparison with immediate exchange and own use alone.

D. *ICs and the Nature of the Firm*

ICs are critical building blocks in the formation of innovative firms. ICs are essential to the "creative destruction" that takes place when innovative entrants compete with incumbent firms. Innovative firms contract with specialized researchers within the firm to develop and manage intangible assets. Innovative firms contract in the market with firms that create, own, or apply intangible assets. Innovative firms use ICs with customers, suppliers, partners, and distributors to introduce new products, production processes, transaction methods, and organizational structures. Innovative firms use ICs to provide multi-sided platforms that offer marketmaking and intermediary services to customers and suppliers.

Contracts are central to the formation of firms. The firm involves both internal and external contractual relationships.[111] The firm's collection of internal and external contracts depends on the relative efficiency and transaction costs of these types of contracts. Steven Cheung interprets Ronald Coase's analysis of the firm in terms of contract: "It is not quite correct to say that a 'firm' supersedes 'the market.' Rather, one type of contract supersedes another type."[112]

A major purpose of the firm is to organize and manage the market for contracts. In my book *The Theory of the Firm*, I show that "[t]he firm is

111. Michael C. Jensen & William H. Meckling, *The Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure*, 3 J. FIN. ECON. 305, 310 (1976) ("[Firms] serve as a nexus for a set of contracting relationships among individuals."); *see* Melvin A. Eisenberg, *The Conception that the Corporation Is a Nexus of Contracts, and the Dual Nature of the Firm*, 24 J. CORP. L. 819, 828 (1998).

112. Steven N.S. Cheung, *The Contractual Nature of the Firm*, 26 J.L. & ECON. 1, 10 (1983). Cheung states that an input owner has the option of own-use, selling the input to others, or creating a firm through contracts delegating the use of the input: "The firm emerges with the third option: the entrepreneur or the agent who holds a limited set of use rights by contract directs production activities without immediate reference to the price of each activity, and the commodities so produced are then sold in the market." *Id.* at 3. *See also* Ronald Coase, *The Nature of the Firm*, 16 ECONOMICA 386 (1937).

an intermediary in the market for contracts."[113] Entrepreneurs establish firms when the benefits of intermediated contracts exceed the benefits of direct exchange: "Firms offer advantages over bilateral contracts through market making and coordination across multiple contracts."[114]

IC relationships are essential to the creation of new types of firms. As I discuss in my book *The Innovative Entrepreneur*, entrepreneurs innovate to overcome the innovative inertia of incumbent firms.[115] Entrepreneurs also innovate to overcome friction in the market for inventions that limit transfers of their technology to incumbent firms.[116] Innovative entrepreneurs develop a complex set of contractual relationships, necessarily including ICs, to create startups and establish firms.

Contracts have well-known transaction costs, including the costs of search, negotiation, moral hazard, adverse selection, monitoring performance, and enforcement of contract terms. ICs have additional transaction costs, including difficulties in pricing IP and the costs of bundling IP with other goods and services.[117] Because of the fundamental uncertainty involved in technological change, ICs have additional costs of forming contingent agreements and monitoring outcomes. Uncertainty associated with invention, innovation, and adoption is likely to be much greater than with contracts involving tangible assets.[118]

The firm's outsourcing decisions concerning invention and innovation also depend on the relative costs of forming and monitoring an employment IC versus an outsourcing IC. The trade-off between governance costs and market transaction costs for ICs is related to Coase's analysis of the scope of the firm's activities and the make-or-buy decision.[119] Coase's analysis applied to technological change suggests that the firm will expand its inventive and innovative activities as long as

113. *See* DANIEL F. SPULBER, THE THEORY OF THE FIRM: MICROECONOMICS WITH ENDOGENOUS ENTREPRENEURS, FIRMS, MARKETS, AND ORGANIZATIONS 415 (2009).

114. *Id.*

115. *See generally* SPULBER, *supra* note 86.

116. *Id.*

117. *See* Richard Zeckhauser, *The Challenge of Contracting for Technological Information*, 93 PROC. NAT'L ACAD. SCI. U.S. 12473, 12473 (1996) ("Contracting to provide technological information (TI) is a significant challenge. TI is an unusual commodity in five ways. (i) TI is difficult to count and value; conventional indicators, such as patents and citations, hardly indicate value. TI is often sold at different prices to different parties. (ii) To value TI, it may be necessary to 'give away the secret.' This danger, despite nondisclosure agreements, inhibits efforts to market TI. (iii) To prove its value, TI is often bundled into complete products, such as a computer chip or pharmaceutical product. Efficient exchange, by contrast, would involve merely the raw information. (iv) Sellers' superior knowledge about TI's value make buyers wary of overpaying. (v) Inefficient contracts are often designed to secure rents from TI.").

118. *See* discussion *infra* Section IV.

119. *See generally* Coase, *supra* 112.

incremental governance costs are less than the transaction costs of outsourcing these activities.[120]

The trade-off between governance costs and transaction costs has important implications for innovative firms. The use of ICs both within the firm and among firms affects the direction of technological change. The reductions in the extent of vertical integration of the firm affect how R&D is organized in the economy. This is reflected in the design of products and production processes. Firms have reduced vertical integration by creating modular products and outsourcing contracts for innovation.[121]

The increasing importance of invention and innovation requires new types of intangible assets and organizations.[122] Implementing technological change requires contractual agreements. Connecting individuals and firms in new ways requires more than networks of innovative technologies with digital links; it is also necessary to connect individuals and firms with networks of contracts that support the formation of these new technological networks. Individuals and firms need legal agreements for cooperative development of virtual inventions and innovations, and to help develop interconnectivity and interoperability of technologies. Individuals and firms also need contracts that support data sharing and investment in data gathering and analytics.

Technological change leading to vertical disintegration requires coordination through ICs between many vertical levels of suppliers. Various technological developments cut across industries, leading to greater reliance on outsourcing and licensing agreements. Technological changes that cross industries include AI, IoT, and ICT.[123]

IC necessarily accompanies the growth of R&D outsourcing and the formation of innovation networks. Firms substitute networks of contracts

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120. *Id.*

121. *See* Timothy J. Sturgeon, *Modular Production Networks: A New American Model of Industrial Organization*, 11 INDUS. & CORP. CHANGE 451, 451 (2002); Carliss Y. Baldwin, *Where Do Transactions Come From? Modularity, Transactions, and the Boundaries of Firms*, 17 INDUS. & CORP. CHANGE 155, 161 (2007); Ronald J. Gilson et al., *Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration*, 109 COLUM. L. REV. 431, 435 (2009) ("Contracting for innovation supports iterative collaboration between firms by interweaving explicit and implicit terms that respond to the uncertainty inherent in the innovation process . . . "); Margaret M. Blair et al., *Outsourcing, Modularity, and the Theory of the Firm*, BYU L. REV. 263, 265–66 (2011).

122. Erik Brynjolfsson et al., *Intangible Assets: Computers and Organizational Capital*, 1 BROOKINGS PAPERS ON ECON. ACTIVITY 137, 138 (2002) ("This paper analytically explores the hypothesis that new, intangible organizational assets complement [information technology] capital just as new production processes and factory redesign complemented the adoption of electric motors over 100 years ago.").

123. Kay Firth-Butterfield & Yoon Chae, *Artificial Intelligence Collides with Patent Law*, CTR. FOR THE FOURTH INDUS. REVOLUTION 3, 5 (Apr. 2018) http://www3.weforum.org/docs/WEF_48540_WP_End_of_Innovation_Protecting_Patent_Law.pdf.

for vertical integration.[124] Contracts among firms substitute for contracts within the firm. Matthew Jennejohn observes, "[w]here property rights no longer control, contracts substitute. In light of these developments, contract's place as one of capitalism's fundamental building-blocks takes on even greater importance."[125]

Many types of invention and innovation require coordination of activities across firms. This is reflected in the increasing importance of technological standards. There are over one thousand standard setting organizations (SSOs) that establish quality and interoperability standards in practically every industry.[126] Changes in technology standards provide an important indication of innovation.[127] Standards include "variety control, usability, compatibility, interchangeability, health, safety, protection of the environment, product protection, mutual understanding, economic performance, trade."[128] For example, the International Organization for Standardization (ISO) has published over 21,000 international standards,[129] playing an important role in the formation of global supply chains. The management literature refers to the extensive technological interdependence among firms as innovative "ecosystems."[130]

II. INTELLECTUAL CONTRACT

Intellectual Law offers a framework for addressing intangible assets in a comprehensive manner. This section examines some of the main differences between ICs and standard contracts; it also sets out five basic principles of IC law. IC involves agreements that resolve some of the incompleteness of IP. IC also helps remedy difficulties in exclusion of access to intangible assets. IC provides agreements when there is non-rivalrous usage of intangible assets. IC provides incentives for

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124. Matthew C. Jennejohn, *Collaboration, Innovation, and Contract Design*, 14 STAN. J. L., BUS. & FIN. 83, 84 (2008) ("Rather, deverticalized firms enmesh themselves in webs of collaboration—joint ventures, strategic alliances, just-in-time (JIT) production arrangements, etc.—usually in hope of cost-cutting but also with an eye to securing competitive advantage through innovation.").

125. *Id*.

126. Daniel F. Spulber, *Standard Setting Organizations and Standard Essential Patents: Voting and Markets* 2 ECON. J., (forthcoming, Apr. 2019), https://doi.org/10.1111/ecoj.12606.

127. *Id*.

128. ISO/IEC GUIDE 2:2004 at 12 (INT'L ORG. FOR STANDARDIZATION & INT'L ELECTROTECHNICAL COMM'N 2004), https://www.iso.org/obp/ui/#iso:std:iso-iec:guide:2:ed-8:v1:en.

129. INT'L ORG. FOR STANDARDIZATION, NAVIGATING A WORLD IN TRANSITION 35 (2016), https://www.iso.org/files/live/sites/isoorg/files/about%20ISO/annual_reports/en/annual_report_2016_en.pdf.

130. *See generally* Ron Adner & Rahul Kapoor, *Value Creation in Innovation Ecosystems: How the Structure of Technological Interdependence Affects Firm Performance in New Technology Generations*, 31 STRATEGIC MGMT. J. 306 (2010).

exploratory performance. Finally, IC addresses problems of contingent contracting when agreements are subject to fundamental uncertainty.

A. *ICs and Incompleteness of IP*

IP suffers from weak enforcement as well as the inherent limitations of government grants and registration. A well-functioning system of property rights requires completeness, exclusivity, and transferability. ICs provide protections for intangible assets based on agreements between inventors, innovators, and adopters. This compensates for incompleteness of legal protections for intangible assets. An advantage of ICs is that they do not require government approval of the IP defined through the agreement. The transaction costs of IC are likely to be substantially lower than costs associated with government administration. Contractually-defined protections are tailored to the particular benefits and costs of the contracting parties and the characteristics of the technology.

The Constitution frames protections for inventors in terms of IP by giving Congress the power to secure exclusive rights for authors and inventors to their writings and discoveries.[131] Patent holders have the right to exclude others from making, using, offering to sell, selling, or importing any patented invention.[132] State governments and all three branches of the federal government are involved in defining and enforcing IP rights.[133] IP policies include legislative limitations on IP, executive policies toward IP—particularly involving the USPTO and antitrust agencies—and judicial decisions on IP. Many practitioners and scholars emphasize the importance of IP protections for inventors.[134]

IP protections for commercial, scientific, and technological creations are far from complete however. IP provides protections in four categories: patents, trademarks, copyrights, and trade secrets.[135] The

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131. U.S. CONST. art. I, § 8, cl. 8 ("The Congress shall have Power . . . To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries"). *See also* Gene Quinn, *Patents, Copyrights and the Constitution, Perfect Together*, IPWATCHDOG (Feb. 19, 2018), http://www.ipwatchdog.com/2018/02/19/patents-copyrights-constitution/id=93941/.

132. *See* 35 U.S.C. § 271 (2018).

133. *Id.*; *see also* Fla. Stat. § 815.04 (2018).

134. *See, e.g.*, Roger D. Blair & Thomas F. Cotter, *An Economic Analysis of Damages Rules in Intellectual Property Law*, 39 WM. & MARY L. REV. 1585, 1615 (1997) ("A substantial number of the law and economics scholars who have written on this subject appear to agree that it is generally preferable to protect intellectual property rights through the use of property, as opposed to liability, rules.").

135. *Trade Secret Policy*, USPTO, https://www.uspto.gov/patents-getting-started/international-protection/trade-secret-policy (last visited Nov. 24, 2018). *But see* WORLD INTELLECTUAL PROP. ORG., WHAT IS INTELLECTUAL PROPERTY? (2003) http://www.wipo.int/

WIPO Convention's definition of IP is more inclusive because it identifies "scientific discoveries" and "all other rights resulting from intellectual activity in the industrial, scientific, literary or artistic fields."[136]

In contrast to tangible property, patents and trademarks require government grants.[137] The USPTO not only registers the property right, but defines and certifies the features of the intangible asset.[138] At the USPTO, professional patent examiners review applications for patents and examining attorneys review applications for trademarks.[139] For inventions to be "patentable," they must satisfy criteria such as first-to-file, novelty, and non-obviousness.[140] For trademarks to be "registrable," there cannot be a "likelihood of confusion" with existing trademarks or pending applications.[141] The chance that a trademark is "registrable" also depends on the category it belongs to: fanciful or arbitrary, suggestive, descriptive, or generic.[142]

There are also limitations for copyright. In fiscal year 2016, the U.S. Copyright Office issued over 414,000 registrations out of 468,000 claims for registration.[143] The U.S. Copyright Office limits types of works and applies subject matter criteria, governed by statute: "In no case does copyright protection for an original work of authorship extend to any idea, procedure, process, system, method of operation, concept, principle,

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edocs/pubdocs/en/intproperty/450/wipo_pub_450.pdf; WORLD INTELLECTUAL PROP. ORG., INTELLECTUAL PROPERTY HANDBOOK 3 (2d ed. 2004), http://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf ("Generally speaking, intellectual property law aims at safeguarding creators and other producers of intellectual goods and services by granting them certain time-limited rights to control the use made of those productions. Those rights do not apply to the physical object in which the creation may be embodied but instead to the intellectual creation as such. Intellectual property is traditionally divided into two branches, 'industrial property' and 'copyright.'").

136. Convention Establishing the World Intellectual Property Organization art. 2, July 14, 1967, 21 U.S.T. 1749, 828 U.N.T.S. 3.

137. Gene Quinn, *SCOTUS Says Patents Are a Government Franchise, Not a Vested Property Right*, IPWATCHDOG (Apr. 24, 2018), https://www.ipwatchdog.com/2018/04/24/scotus-says-patents-government-franchise-not-vested-property-right/id=96324/; *see also* Oil States Energy Servs., LLC v. Greene's Energy Grp., LLC, 138 S. Ct. 1365, 1373 (2018).

138. *See* 35 U.S.C. § 2(a) (2018).

139. *See* 35 U.S.C. § 131 (2018); 15 U.S.C. § 1051 (2018).

140. *See* 35 U.S.C. §§ 100–03 (2018).

141. USPTO, PROTECTING YOUR TRADEMARK: ENHANCING YOUR RIGHTS THROUGH FEDERAL REGISTRATION 3 (2016), https://www.uspto.gov/sites/default/files/documents/BasicFacts.pdf.

142. *Id.* at 7.

143. *Overview of the Copyright Office*, U.S. COPYRIGHT OFFICE, https://www.copyright.gov/about/ (last visited Jan. 21, 2019).

or discovery, regardless of the form in which it is described, explained, illustrated, or embodied in such work."[144]

IP offers weaker protections for inventors than protections for traditional property rights. In contrast to tangible property, patents limit the time period of exclusive rights. The regulatory time limit is a form of incompleteness. Richard Epstein argues that limiting the time period of exclusive rights transforms tangible property rules to intangible property rules.[145] Epstein suggests that limiting the time period for exclusion, use, and disposition is similar to other limits placed on property generally, including the law of private and public necessity and antitrust limitations on collusion.[146]

Subject matter limitations are another major form of incompleteness for IP.[147] The subject matter limitations for patentability under the statute specify "any new and useful process, machine, manufacture, or composition of matter."[148] The Supreme Court in *Bilski* questioned whether business method inventions should be patentable.[149] The decision cast doubt on many existing business method patents and the full range of commercial inventions, including Internet commerce software applications.[150] The Supreme Court decision in *Mayo* raised issues about biotechnology inventions by diagnostic tests for administering pharmaceuticals.[151] The Court rejected the invention using a two-step test that first determined whether the invention consisted of "abstract ideas, laws of nature, or natural phenomena," then examined whether the invention would "transform the nature of the claim" into something

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144. 17 U.S.C. § 102 (2018).

145. Richard A. Epstein, *The Disintegration of Intellectual Property? A Classical Liberal Response to a Premature Obituary*, 62 STAN. L. REV. 455, 459 (2010) ("As I shall argue, the single adoption of one adjustment, and one adjustment only, goes a very long way to ease the transformation from tangible to intangible property. Just use limited terms of exclusive rights, longer for copyrights than patents, to work the transformation from tangible property to these two vital forms of intellectual property. At that point, the remainder of the rules that deal with tangible property, namely those that concern exclusion, use, and disposition, can be carried over without difficulty.").

146. *Id.*

147. USPTO, PATENT ELIGIBLE SUBJECT MATTER: REPORT ON VIEWS AND RECOMMENDATIONS FROM THE PUBLIC UNITED STATES PATENT AND TRADEMARK OFFICE (2017), https://www.uspto.gov/sites/default/files/documents/101-Report_FINAL.pdf.

148. 35 U.S.C. § 101 (2018).

149. Bilski v. Kappos, 561 U.S. 593 (2010).

150. *Id.*; *see also* Daniel F. Spulber, *Should Business Method Inventions Be Patentable?*, 3 J. LEGAL ANALYSIS 265, 267 (2011).

151. Mayo v. Prometheus, 132 S. Ct. 1289 (2012).

patentable.[152] The Supreme Court applied the two-step test in *Alice* to reject a business invention for intermediated settlement.[153]

IP also provides incomplete protections because patents do not cover many incremental inventions.[154] The costs and difficulties in obtaining and maintaining a patent can be very high.[155] This inevitably generates an expected value threshold for patent protections. An inventor will not apply for a patent unless the expected value of patenting the invention exceeds the costs of obtaining the patent. Consequently, patent protections are incomplete because they do not cover inventions with expected values below the threshold.

ICs help protect discoveries in the lower tail of the distribution of the market value of inventions. IP tends to cover the upper tail of inventions and other intangible assets.[156] Let C represent the expected legal costs and fees of obtaining and maintaining IP such as patents. Let Y be the market value of the IP, including own use by the IP holder, if found to be valid by the courts. Let P be the likelihood that IP is found to be valid by the courts and survives administrative challenges. Then, it is not worthwhile obtaining IP if the expected benefits PY are less than the expected costs C. This type of IP is the lower tail of the net value distribution of intangible assets. Yet, incremental discoveries are generated routinely and are highly important within the firm. There are many discoveries in the lower tail of the distribution of the market value of inventions.[157]

In addition, patent application criteria and uncertainty in review by patent examiners limit coverage for inventors. Many discoveries may be original but not meet formal IP criteria, including those based on laws of

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152. USPTO, *supra* note 147, at 8.

153. Alice Corp. v. CLS Bank Int'l, 134 S. Ct. 2347 (2014).

154. Gene Quinn, *Protecting Ideas: Can Ideas Be Protected or Patented?*, IP WATCHDOG (Feb. 15, 2014), http://www.ipwatchdog.com/2014/02/15/protecting-ideas-can-ideas-be-protected-or-patented/id=48009/.

155. Quinn, *supra* note 29 ("Thanks to the United States Supreme Court, the United States Court of Appeals for the Federal Circuit and ever more regulations from the United States Patent and Trademark Office it has become more difficult over the years to create the type of written description and claim sets required.").

156. Jill Green & Melody Wirz, *Whose Idea Is it Anyway? 10 IP Issues in Deals*, ACC DOCKET, Dec. 2010, at 40.

157. *See* Bronwyn H. Hall and Rosemarie H. Ziedonis, *The Patent Paradox Revisited: An Empirical Study of Patenting in the US Semiconductor Industry, 1979-1995*, 32 RAND J. ECON., 101 (2001); Lee Fleming, *Breakthroughs and the "Long Tail" of Innovation*, 49 MIT SLOAN MGMT. REV. 69 (2007); Cédric Schneider, *External Knowledge Sourcing: Science, Market and the Value of Patented Inventions*, 30 MANAGERIAL AND DECISION ECON. 551 (2009); and Gaétan De Rassenfosse, *Do Firms face a Trade-Off between the Quantity and the Quality of their Inventions?*, 42 RESEARCH POLICY 1072 (2013).

nature, non-obviousness, and usefulness.[158] These considerations eliminate property protections for inventions that do not pass through formal review and meet the regulatory criteria. The risks of the review process further increase the expected value threshold for patent protections.[159] Fewer inventors seeking patent protections which further increases the incompleteness of IP.

IP protections also are incomplete because of costs and inaccuracies in the legal and regulatory systems. Patent holders face costs of detecting and monitoring infringement.[160] The legal costs of obtaining compensation for infringement are significant. Additionally, patents are subject to costly legal challenges in terms of validity and infringement. Unavoidable legal errors, inconsistencies, and technical issues further limit IP protections for some useful and original inventions. Patents are also subject to challenge at the Patent Trial and Appeal Board (PTAB) within the USPTO, which may also be subject to error.[161] Taken together, these costs and risks create another type of value threshold for patent protections. Patents with an expected value below this threshold will not have IP protections.

Stronger protections for trade secrets address some of these limitations. More companies rely on protections from trade secrets and trademarks than from copyrights and patents.[162] Trade secrets do not require formal government grants of IP.[163] Ivan Png points out that “trade

158. Gene Quinn, *Patentability: The Nonobviousness Requirement of 35 U.S.C. 103*, IP WATCHDOG (June 17, 2017), http://www.ipwatchdog.com/2017/06/17/patentability-nonobviousness-35-usc-103/id=84716/.

159. Neal Solomon, *The Problem of Patent Valuation*, IP WATCHDOG (Aug. 15, 2017), http://www.ipwatchdog.com/2017/08/15/problem-patent-valuation/id=86840/.

160. Rebecca S. Eisenberg, *Patent Costs and Unlicensed Use of Patented Inventions*, 78 U. CHI. L. REV. 53, 54–55 (2011).

161. Gene Quinn, *PTAB Judges Shockingly Inexperienced Compared to District Court Judges*, IP WATCHDOG (Mar. 6, 2018), http://www.ipwatchdog.com/2018/03/06/ptab-judges-shockingly-inexperienced/id=94438/ (“The America Invents Act (AIA) invests PTAB judges with extraordinary powers. For example, overwhelmingly institution decisions are not appealable. Yet, there have been numerous lawyers with shockingly little experience appointed to the position of patent judge, and vested with the power to make decisions that cannot be reviewed by any Article III federal court.”).

162. *See* JOHN E. JANKOWSKI, NAT’L SCI. FOUND., BUSINESS USE OF INTELLECTUAL PROPERTY PROTECTION DOCUMENTED IN NSF SURVEY 1 (2012), http://wayback.archive-it.org/5902/20181004073804/https://www.nsf.gov/statistics/infbrief/nsf12307/nsf12307.pdf (“New survey findings from the National Science Foundation (NSF) and the U.S. Census Bureau (Census) indicate that trademarks and trade secrets are identified by the largest number of businesses as important forms of IP protection, followed by copyrights, and then patents.”); *see generally* JAMES POOLEY, TRADE SECRETS (2017).

163. Shane E. Olafson, *Patents vs. Trade Secrets—Giving Your Business the Competitive Edge,* ARIZ. BIOINSIDER (Apr. 1, 2007), https://www.lrrc.com/files/Uploads/Documents/Olafson_AZBioInsider.pdf.

secrets can be unlimited in time, are not limited by particular technical standards, and do not require disclosure. Moreover, the scope of trade secrecy is much broader, extending to work in progress as well as completed innovations."[164] Individual states' adoption of the Uniform Trade Secrets Act (UTSA) has increased protections for inventors and innovators.[165] Png finds that state adoption of the UTSA has tended to increase R&D.[166]

Although trade secrets cover works in progress, they are not sufficient to protect the continual sharing of information within and among firms. Many lower tail discoveries must be disclosed to employees and the firm's customers, suppliers, and partners.[167] ICs overcome some of the limitations of trade secret protections. IC protections, such as non-disclosure agreements (NDAs), address the need to share various trade secrets in employment and outsourcing.[168]

ICs help protect cooperative use of knowledge and intangible assets not covered by formal IP. Technological change involves repeated interactions over time between a firm and its employees and among firms. This interaction involves continual sharing of small increments of knowledge. The formal apparatus of IP cannot protect such small increments of knowledge because IP is geared to larger increases in knowledge. This is because the sharing of small increments of knowledge is often informal and incomplete. Also, the costs of obtaining government grants of IP are necessarily prohibitive for small increments of knowledge. Continual sharing of knowledge may involve relational contracts because of the need for trust and implicit agreements that cannot be achieved with IP.

B. *ICs and Excludability of IP*

Parties can form ICs to allocate ownership of intangible assets and to specify how those assets will be used. These private agreements depend on contract rules and private negotiation. ICs resolve problems related to the excludability of intangible assets. The parties to an IC can choose the

164. I.P.L. Png, *Law and Innovation: Evidence from State Trade Secrets Laws*, 99 REV. ECON. & STAT. 167, 168 (2017).

165. *Id*. at 175.

166. *Id*.

167. Evelyn D. Pisegna-Cook, *Ownership Rights of Employee Inventions: The Role of Preinvention Assignment Agreements and State Statutes*, 2 U. BALT. INTELL. PROP. L.J. 163, 163 (1994).

168. Epstein, *supra* note 145, at 458 ("Any agreement, for example, whereby a trade secret is shared pursuant to a confidentiality agreement involves the simultaneous transmission and retention of information—but only if the contractual arrangements are given strong protection, as they typically are.").

desired extent of exclusion. The effectiveness of IP should be considered in combination with ICs.

Legal barriers limiting access to IP substitute for the lack of physical barriers. It is more difficult for IP owners to limit, deter, and monitor access to intangible assets in contrast to tangible assets.[169] Peter Menell notes that "even if someone claims to own the knowledge, it is difficult to exclude others from using it. Intellectual property law is an attempt to solve that problem by legal means."[170] R&D can generate positive externalities because knowledge can be costless for others to learn and distribute while it can be costly for IP holders to monitor usage by others. Positive externalities from R&D often are referred to as R&D "spillovers."[171]

The debate over patent scope considers the effects of legal exclusion on sequential invention and innovation. Robert Merges and Richard Nelson argue that patent scope should be narrow so as to encourage rivalry among inventors.[172] They express concerns that narrow patents will favor pioneer inventors and block competing inventors.[173] Advocates of narrow patent scope argue that exclusion creates monopoly rents for patent holders.[174] The advantages of not protecting patent holders' investments in developing an invention are inducing investment in developing and applying the invention by later inventors.[175]

Others argue that patent scope should be sufficiently broad to help inventors develop their own inventions without incursion by later inventors.[176] Broader patent protections encompassing future development encourage inventors to invest in improving and

169. Owners of buildings and land can place fences around their properties. Owners of automobiles and other vehicles can equip them with locks and other antitheft devices. Companies have various mechanisms for deterring theft of their goods, equipment, and financial assets.

170. Menell, *supra* note 31, at 726.

171. Pere Arqué-Castells & Daniel F. Spulber, *Measuring the Private and Social Returns to R&D: Unintended Spillovers Versus Technology Markets* (Nw. L. & Econ. Research, Paper No. 18-18, 2019), http://dx.doi.org/10.2139/ssrn.3202870.

172. *See* Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839 (1990); Robert P. Merges & Richard R. Nelson, *On Limiting or Encouraging Rivalry in Technical Progress: The Effect of Patent Scope Decisions*, 25 J. ECON. BEHAV. & ORG. 1, 6 (1994).

173. *See* sources cited *supra* note 172.

174. Michele Boldrin & David K. Levine, *The Case Against Patents*, 27 J. ECON. PERSP. 3, 18 (2013).

175. *See* Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. ECON. PERSP. 29, 30 (1991).

176. On arguments for broader patent scope, see Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265 (1977); Daniel F. Spulber, *How Patents Provide the Foundation of the Market for Inventions*, 11 J. COMP. L. & ECON. 271 (2015).

commercializing their patented inventions.[177] Broader patent protections also support investment in creating the initial invention and encourage disclosure of inventions.[178] Also, broader patent protections allow patent holders to choose the mix of own use and outsourcing efficiently based on the relative economic returns to these activities.

With positive externalities from R&D, the social benefits of the initial invention are greater than the private benefits to the initial inventor. With broader patent scope, there is greater protection for IP rights of inventors and correspondingly fewer R&D spillovers. Conversely, with narrower patent scope, there is less protection for IP rights of inventors and correspondingly more R&D spillovers.

The problem of patent scope is thus similar to the problem of social cost. The social costs of an activity are defined as the total of private costs.[179] The social costs of an activity exceed the private costs to the owner of an activity when the activity imposes costs on others.[180] The costs or harm imposed on others are referred to as a negative externality if the costs are not part of a market transaction between the parties. Coase showed that private negotiation achieves efficiency regarding the extent of negative externalities when transaction costs are low and few parties are involved.[181] Coase emphasized that the assignment of property rights does not affect the efficiency of the outcome because the negotiating parties maximize their joint benefits.[182] If the party creating harm has property rights, the party suffering harm will pay them to stop.[183] If the party suffering harm has property rights, the party creating harm will be forced to pay compensation.[184] The extent of the activity will be such that the marginal private benefit to the party causing harm will equal the marginal damage to the party suffering harm.[185] The only effect of the initial assignment of property rights is distributional because the party with property rights will benefit at the expense of the party without property rights.[186]

When transaction costs are low and few parties are involved, the parties are able to attain an efficient outcome regardless of the assignment of property rights.[187] However, when transaction costs are high and many

177. Kieff, *supra* note 92, at 710.
178. Kitch, *supra* note 176, at 278.
179. ARTHUR CECIL PIGOU, THE ECONOMICS OF WELFARE 189 (4th ed. 1932).
180. *Id.*
181. Ronald H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960).
182. *Id.* at 6.
183. *Id.* at 9.
184. *Id.*
185. *Id.* at 3.
186. *Id.* at 5.
187. *Id.* at 6.

parties are involved, the assignment of property rights can affect the outcome.[188] This is because frictions may prevent or distort bargaining, thus preventing the parties from attaining an efficient outcome. It is then more efficient to assign property rights so as to minimize transaction costs. For example, there may be a few firms engaged in the activity that causes harm and many individuals suffering harm from the external effects of the activity. It is then more efficient to assign property rights to those suffering harm.

ICs can address the problem of patent scope and the effects of positive externalities from R&D. When transaction costs are low and few parties are involved, contract negotiation should attain the efficient outcome regardless of patent scope. If patent scope is narrow, the party benefitting from the initial invention can pay the inventor to conduct R&D. If patent scope is broad, the party benefitting from the initial invention can pay the inventor to use the invention, thus providing additional incentives for the inventor. The parties will reach an efficient agreement regardless of the initial assignment of IP rights.

ICs may not fully remedy the problem of patent scope when transaction costs are high and many parties are involved. In this situation, the choice of patent scope does affect economic efficiency. It is necessary for patent policy to assign property rights that achieve the right mix of initial and sequential invention. This suggests the need for broader patent scope because licensing the invention to later inventors should involve lower transaction costs than providing subsidies to potential initial inventors. As Merges points out, many potential buyers and high transaction costs suggest the need for stronger IP to support contracts.[189]

The length of patent life affects the initial inventor's returns from transferring or licensing the patent to the second inventor.[190] Also, the scope of the patent affects the extent to which sequential invention requires the second inventor to acquire or license the intangible assets of

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188. Harold Demsetz, *Information and Efficiency: Another Viewpoint*, 12 J.L. ECON. 1, 13 (1969) ("If the cost of contracting is positive, the kind of property rights system that is established may change the allocation of resources in the production of knowledge.").

189. Robert P. Merges, *Of Property Rules, Coase, and Intellectual Property*, 94 COLUM. L. REV. 2655, 2662 (1994) ("Even though there are many dispersed buyers (and sellers) of IPRs, and even though the transaction costs of IPR exchanges are otherwise high, the strong property rule baseline often works quite well. The frequency of contracting in many markets for IPRs—an underdeveloped theme in most of the entitlements literature—gives rise to a myriad of institutions (broadly defined) designed to streamline the exchange of property rights.").

190. *See* Jerry R. Green & Suzanne Scotchmer, *On the Division of Profit in Sequential Innovation*, 26 RAND J. ECON. 20, 21 (1995); Ted O'Donoghue et al., *Patent Breadth, Patent Life, and the Pace of Technological Progress*, 7 J. ECON. & MGMT. STRATEGY 1, 2 (1998); John H. Barton, *Patents and Antitrust: A Rethinking in Light of Patent Breadth and Sequential Innovation*, 65 ANTITRUST L.J. 449, 450 (1997).

the first inventor.[191] ICs allow the allocation of returns among sequential inventors. Nancy Gallini argues that shorter lived, broad patents promote diffusion of inventions but longer lived, narrow patents lower R&D costs.[192] Amy Landers recommends that in patent disputes, courts should consider sequential invention and defines apportionment as "an examination of the differences between the infringed claim and the prior art in a manner analogous to the identification of the differences between the claimed invention and the prior art in the non-obviousness analysis."[193]

ICs also provide an important mechanism for addressing positive externalities in R&D.[194] Firms can internalize these benefits through licensing or cross-licensing agreements. Firms also can internalize positive externalities by creating RJVs and R&D consortia. Companies forming RJVs may employ covenants not to compete (CNCs) to coordinate their R&D activities. This type of CNC is a form of IC. CNCs date back over three centuries.[195] Sarath Sanga points out that corporate joint ventures involve an inherent fiduciary conflict between each company's duty to its own interests and its duty to the interests of a partner.[196] Sanga argues that this conflict of interests is resolved not only by operating the joint venture as a separate entity, but though the use of a CNC.[197]

ICs address problems arising from insufficient exclusivity of IP. Firms must disclose IP within their organizations. Firms licensing IP must disclose the features of the invention. Kenneth Arrow observed that offering inventions for sale or license involves revealing the secret.[198] Inventors must disclose their technology in order to obtain a patent. Trademarks and copyrighted works only have value if used openly.

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191. *See* O'Donoghue et al., *supra* note 190, at 2; Barton, *supra* note 190, at 449.

192. Nancy T. Gallini, *Patent Policy and Costly Imitation*, 23 RAND J. ECON. 52, 53 (1992).

193. Amy L. Landers, *Patent Claim Apportionment, Patentee Injury and Sequential Invention*, 19 GEO. MASON L. REV. 471, 476 (2012).

194. For some discussion of spillovers and RJVs, see Claude D'Aspremont & Alexis Jacquemin, *Cooperative and Noncooperative R&D in Duopoly with Spillovers*, 78 AM. ECON. REV. 1133 (1988); Kotaro Suzumura, *Cooperative and Noncooperative R&D in an Oligopoly with Spillovers*, 82 AM. ECON. REV. 1307 (1992).

195. Harlan M. Blake, *Employee Agreements Not to Compete*, 73 HARV. L. REV. 625, 629 (1960).

196. Sarath Sanga, *A Theory of Corporate Joint Ventures*, 106 CAL. L. REV. 1437, 1438 (2018).

197. *Id.* at 1454.

198. Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, 0-87014-304-2 NAT'L BUREAU OF ECON. RES. 609, 615 (1962), https://www.nber.org/chapters/c2144.pdf.

ICs also help control technology transactions that occur when employees who switch jobs convey knowledge and inventions from their previous employer to their new one. Ronald Gilson includes legal frameworks as a source of agglomeration economies driving places like California's Silicon Valley.[199] Gilson emphasizes the importance of CNCs that facilitate employee job switching while protecting a company's intangible assets.[200] These types of CNCs also function as ICs.

Legal barriers provide weaker protections for intangible assets than for tangible assets. ICs remedy weaknesses in legal protections for IP. Infringement of a patent occurs when someone "without authority makes, uses, offers to sell, or sells any patented invention, within the United States or imports into the United States any patented invention during the term of the patent . . . "[201] An IC specifies who will make, use, offer to sell, or sell an invention, and places additional limitations on use and the amount of compensation. Enforcement of the agreement provides protections of the contracting parties' expectations.

C. *ICs and Non-Rivalrous Usage of IP*

Non-rivalrous usage of intangible assets distinguishes ICs from standard contracts involving tangible assets. ICs handle the non-rivalrous usage of intangible assets by facilitating allocation and sharing among multiple adopters. ICs support cooperation in developing and combining intangible assets. For example, a patent holder can grant access to an invention to multiple users by offering multiple patent license contracts.

ICs help define the characteristics and boundaries of intangible assets. Agreements between inventors, innovators, and adopters specify the features of technology being shared or transferred. Contracts adjust to the benefits and costs of the parties to the agreement and the needs of the industries in which they do business.

Some argue that IP should not receive the same legal protections as tangible property because of extensive interdependence associated with information. For example, Menell asserts: "Intellectual property has never fit the real property mold particularly well and the inherent attributes of intellectual resources as well as the increasingly interdependent nature of information ecosystems points away from the [property rights movement's] PRM's conception of property."[202]

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199. Ronald J. Gilson, *The Legal Infrastructure of High Technology Industrial Districts: Silicon Valley, Route 128, and Covenants Not to Compete*, 74 N.Y.U. L. REV. 575, 577 (1999).

200. *Id.*

201. 35 U.S.C. § 271 (2018).

202. Menell, *supra* note 31, at 753.

Yet, as Polk Wagner observes, even open source advocates seek control: "[D]espite rhetoric to the contrary, it seems quite clear that the 'open' in open source is actually rather tightly controlled, albeit in the name of generally greater access along certain philosophically-favored dimensions."[203] Polk points out that even open source advocates turn to contracts for coordination:

> It should come as no surprise that participants in open source development efforts recognize the need for external coordination, chiefly attempting to accomplish this through the licensing of intellectual property rights to the software. Such licenses are not trivial; perhaps the best known open source license, the GNU General Public License (GPL), has been noted as an aggressive approach to both contract and copyright law, purporting to bind all subsequent users of the software to the terms of the original license.[204]

Transactions among inventors, innovators, and technology adopters depend on effective IC rules. ICs that protect the expectation interests of investors generate the benefits of interdependence in markets for invention. IP provides the foundation for the market for inventions.[205] ICs realize the benefits of coordination among creators and IP users. ICs provide parties with mechanisms to benefit from non-rivalrous usage of intangible assets.

D. *ICs and Incentives for Exploratory Performance*

An IC must solve the critical problem of designing incentives for what I refer to as exploratory performance. With technological change, the characteristics of the outcomes of invention, innovation, and technology adoption are likely to be unknown. The uncertainty involved is more complex than a lottery over known outcomes.

Uncertainty about the characteristics of outcomes increases transaction costs of contracting.[206] This distinguishes ICs from standard contracts involving tangible assets. Difficulties in specifying

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203. R. Polk Wagner, *Information Wants to Be Free: Intellectual Property and the Mythologies of Control*, 103 COLUM. L. REV. 995, 1031 (2003).

204. *Id.* at 1030.

205. Spulber, *supra* note 77, at 271.

206. On transaction costs of contract formation, see Coase, *supra* note 112, and Coase, *supra* note 181, at 15–16.

performance also will affect the incentives of parties involved in contract negotiation.[207]

An IC must specify the bargain when the characteristics of outcomes are unknown. With unknown outcomes, it becomes difficult to specify what performance is being offered and what performance is being accepted. The problems of defining and verifying performance make it difficult to determine the intent of the parties.

Almost all invention, innovation, and technology adoption involves delegation, whether it be to specialized personnel, managers, or firms.[208] So, an IC is likely to be subject to the two main forms of agency costs resulting from moral hazard and adverse selection.[209] A moral hazard problem arises when the employee's actions are imperfectly observable or verifiable.[210] Then, the IC must be based on some measure of performance generated by the employee's actions. Because there is a tradeoff between the cost of inducing action and the benefits of the action, the agent's action will differ from what would be chosen with observable actions.[211] The agent may not choose an efficient level of effort or investment.[212] Here, an efficient level of effort or investment refers to actions that maximize the joint benefits of the contracting parties. If the agent's activity is subject to additional uncertainty, it is not possible to infer the agent's effort from the resulting output. Contracts must therefore provide incentives to the agent or partner to generate effort or investment. Contractual incentives are based on the measure of performance and reward hidden actions indirectly.

An IC is also likely to be subject to adverse selection. An adverse selection problem arises if the employee has hidden information.[213] Even if the agent's action is observable and legally verifiable, the other party will not know what would have been the most efficient action. To address this problem, it is necessary to reward the agent's performance. There is

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207. The costs and rules of contract formation affect the incentives of parties involved in contract negotiation, see Coase, *supra* note 181; Avery Katz, *The Strategic Structure of Offer and Acceptance: Game Theory and the Law of Contract Formation*, 89 MICH. L. REV. 215, 230 (1990).

208. Poblete & Spulber, *supra* note 39, at 39 ("Firms must design and apply incentive contracts for specialized economic agents who conduct R&D because most R&D is a delegated activity. The skills, knowledge and personnel necessary for the invention often differ from those needed for other production and operating activities and generally require independent business units. Companies and government agencies conduct R&D in-house by employing specialized experts such as scientists, engineers, and statisticians.").

209. Masako N. Darrough & Neal M. Stoughton, *Moral Hazard and Adverse Selection: The Question of Financial Structure*, 41 J. FIN. 501, 501 (1986).

210. *Id.*

211. Gustavo Manso, *Motivating Innovation*, 66 J. FIN. 1823, 1830 (2011).

212. Poblete & Spulber, *supra* note 39, at n.6.

213. Darrough & Stoughton, *supra* note 209, at 501.

a tradeoff between the cost of inducing the agent to tell the truth and benefits of obtaining an accurate report.[214] To induce truth telling, it may be necessary to allow a distortion of the agent's effort away from the efficient level of effort.[215]

Contracting costs associated with exploratory performance may differ from the agency costs associated with moral hazard and adverse selection. An IC can address the problem of determining exploratory performance when there is a general measure of benefits for one of the parties.[216] For example, a firm can base the rewards for specialized R&D personnel on the overall performance of the firm. This can be achieved by providing stock options for both managers and specialized R&D personnel.[217] Software companies provide long-term incentive contracts, such as stock options, to engineers and programmers involved in invention and innovation.[218] Firms making substantial investments in R&D may engage in greater delegation of authority and provide more stock options as incentives for non-executive employees.[219] Companies are also significantly increasing the use of long-term incentive contracts for managers of R&D units.[220]

The problem of rewarding exploratory performance is related to the issue of rewarding agents when the contract cannot be based on the principal's objective. Difficulties in measuring performance limit

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214. *See* Roger B. Myerson, *Perspectives on Mechanism Design in Economic Theory*, 98 AM. ECON. REV. 586, 587 (2008) ("[I]ncentive constraints express the basic fact that individuals will not share private information or exert hidden efforts without appropriate incentives.").

215. *See* PATRICK BOLTON & MATHIAS DEWATRIPONT, CONTRACT THEORY 95–96 (2005); JEAN-JACQUES LAFFONT & DAVID MARTIMORT, THE THEORY OF INCENTIVES 29 (2002); Michael C. Jensen & William H. Meckling, *Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure*, 3 J. FIN. ECON. 305, 308 (1976).

216. Poblete & Spulber, *supra* note 39, at 54.

217. *Id.* at 38.

218. Fredrik Andersson et al., *Reaching for the Stars: Who Pays for Talent in Innovative Industries?*, 119 ECON. J. F308, F327 (2009) ("We show that software firms that operate in software sectors with highly skewed returns to innovation, or high upside gains to innovation, are more likely to attract and pay for highly talented workers. Such firms do so first by paying more up-front in starting salaries to attract skilled employees and second by rewarding workers handsomely for experience or loyalty.").

219. John E. Core & Wayne R. Guay, *Stock Option Plans for Non-Executive Employees*, 61 J. FIN. ECON. 253, 272 (2001) ("Firms with greater monitoring costs and greater growth options (proxied by firm size, the book-to-market ratio, and R&D expense) provide greater option incentives to non-executive employees.").

220. Josh Lerner & Julie Wulf, *Innovation and Incentives: Evidence from Corporate R&D*, 89 REV. ECON. STAT. 634, 634 (2007) ("Among firms with a centralized R&D organization, a clear relationship emerges: more long-term incentives granted to corporate R&D heads are associated with more heavily cited patents. These incentives also appear to be associated with more frequent awards and patents of greater originality.").

reliance on monitoring employees.[221] However, "high-powered" incentives directly tied to individual performance are often problematic. For example, rewarding R&D personnel based on the number of patents may generate lower quality patents than rewards based on overall performance of the firm.[222] Even if the profit or stock price of the firm is observable, it can be difficult to anticipate the relationship between the benefits to the firm and the outcome of invention, innovation, or technology adoption.

Measuring performance may be problematic when basic inventions must undergo extensive development. This can generate delays in realizing the benefits of scientific and technological discoveries. Basic inventions often do not generate market returns without commercialization.[223] Obtaining rewards from inventions generally requires application in innovative products, production processes, and transaction methods.[224]

Another important aspect of ICs is that specialized research personnel engaged in exploratory performance may respond well to intrinsic motivation.[225] When R&D employees respond to intrinsic motivation, they may have an increased willingness to take risks.[226] Risk taking may be desirable in R&D because employees may pursue projects involving greater creativity and may devote more effort to experimentation.[227] Companies can design contracts and rewards that emphasize intrinsic motivation.

Kevin Murdock argues that the pharmaceutical company Merck's Mectizan Donation Program illustrates contracting with intrinsic motivation.[228] Merck developed the drug Mectizan as a cure for river blindness and offered the drug to potential users for free.[229] The Mectizan Donation Program states that it is "the longest-running drug donation program for Neglected Tropical Diseases," with over 300 million

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221. Armen A. Alchian & Harold Demsetz, *Production, Information Costs, and Economic Organization*, 62 AM. ECON. REV. 777, 780 (1972).

222. *See* George P. Baker, *Incentive Contracts and Performance Measurement*, 100 J. POL. ECON. 598, 609 (1992).

223. David M. Anderson, *Commercialization*, HALF COST PRODUCTS, http://www.halfcostproducts.com/commercialization.htm (last visited Nov. 9, 2018).

224. *Id.*

225. Todd Dewett, *Linking Intrinsic Motivation, Risk Taking, and Employee Creativity in an R&D Environment*, 37 R&D MGMT. 197, 197 (2007).

226. *See id.*; *see also* Markus Baer et al., *Rewarding Creativity: When Does it Really Matter?*, 14 LEADERSHIP Q. 569, 571 (2003).

227. Dewett, *supra* note 225, at 204.

228. Kevin Murdock, *Intrinsic Motivation and Optimal Incentive Contracts*, 33 RAND J. ECON. 650, 653 (2002).

229. *Id.*

treatments per year for river blindness (onchocerciasis) and lymphatic filariasis elimination.[230] According to Murdock, a firm and its research personnel derive gains from trade when employees have intrinsic motivation.[231] Although the Mectizan project had negative financial returns for Merck, the firm benefitted because its research employees worked harder on other projects.[232] With intrinsic motivation, a firm realizes benefits from joint enforcement of multiple implicit contracts.[233]

Richard Gruner argues that patents encourage inventors to "dream big" and complete their projects.[234] He identifies some psychological aspects of invention and innovation that can generate errors:

> At least four psychological factors make it difficult for inventors to produce successful inventions based on distinctively new designs. These include: 1) difficulties in projecting the capabilities of new technologies in ways that point to new and distinctively different product designs; 2) divergences in the knowledge and experience of product inventors and product users, causing inventors to imperfectly understanding the functional needs and problems of potential invention users; 3) gaps in knowledge and experience of product inventors concerning the contexts where new inventions will be produced, supplied, and used, and; 4) inabilities of inventors to fully imagine the impacts of new inventions in use and the relative happiness of users with new inventions compared with alternative means for producing similar practical results.[235]

Gruner suggests changes in patent laws that would provide incentives for inventors that overcome these psychological problems.[236] However, it is unlikely that patent law can be fine-tuned to address problems of inventor imagination.

In contrast, private ordering through contract terms can avoid the problems of a one-size-fits-all system of government grants. Patent

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230. *Overview*, MECTIZAN DONATION PROGRAM, https://mectizan.org/what/overview/ (last visited Nov. 11, 2018).

231. Murdock, *supra* note 228, at 651.

232. *Id.* at 667 ("When workers are intrinsically motivated, there are 'gains from trade' that arise when the firm implements a project that has negative financial return but generates large intrinsic returns to the agent.").

233. *Id.*

234. Richard S. Gruner, *Imagination, Invention, and Patent Incentives: The Psychology of Patent Law*, 2017 U. ILL. J.L. TECH. & POL'Y 375, 435 (2017).

235. *Id.* at 380.

236. *Id.* at 382.

examination rules are legal standards applied by patent examiners.[237] In contrast to these legal rules, firms can be flexible and adaptable. Firms can adjust contract terms depending on the industry, the product, the type of technology, and even the capabilities of individual researchers. Firms can also vary contract terms over time in response to changes in competition, scientific discoveries, regulation, and consumer demand.

Through the use of ICs, firms are able to design contracts that improve incentives for exploratory performance for employees, managers, and subcontractors. Firms can induce exploratory performance by offering basic rewards contingent on the overall financial performance of the firm. Firms can coordinate invention, commercialization, and innovation to provide rewards for exploratory performance. Firms can offer a combination of extrinsic rewards and intrinsic motivation to help induce creative performance. Firms can design ICs that help inventors overcome psychological barriers to creativity.

E. *ICs and Fundamental Uncertainty*

Technological change involves fundamental uncertainty that may not be present in most standard contracts.[238] ICs provide basic mechanisms such as royalties and options that address fundamental uncertainty.[239] Even when parties to a contract face risk with a known likelihood of events, it is difficult and costly to form contingent contracts.[240] With fundamental uncertainty, contingent contracting becomes more difficult—to the point that any IC will likely be incomplete. Contract law tends to limit contractual constraints on renegotiation and therefore favors simpler contract forms.[241]

Parties forming ICs encounter various forms of fundamental uncertainty that I refer to as statistical, discovery, creativity, and market uncertainty. Statistical uncertainty describes researchers' uncertainty about the outcome of their experiments. Researchers typically design experiments and gather the data generated by those experiments. Researchers usually do not know the characteristics of the population

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237. *See* Stuart J.H. Graham et al., *The USPTO Patent Examination Research Dataset: A Window on Patent Processing*, 27 J. ECON. & MGMT. STRATEGY 554, 557 (2018).

238. *See generally* DAVID C. MOWERY & NATHAN ROSENBERG, TECHNOLOGY AND THE PURSUIT OF ECONOMIC GROWTH (1989). I do not consider various types of legal uncertainty that may affect ICs. These include uncertainty about approval of a patent application and whether a patent will be found to be valid and infringed in court proceedings.

239. *See* Poblete & Spulber, *supra* note 39, at 54.

240. *See* Ronald A. Dye, *Costly Contract Contingencies*, 26 INT'L ECON. REV. 233, 233–34 (1985).

241. Schwartz & Watson, *supra* note 38, at 26; *see* Poblete & Spulber, *supra* note 39 (discussing of renegotiation possibility effects on the form of incentive contracts).

from which the data was drawn, which is typically expressed as the lack of knowledge about the form of the probability distribution regarding some features of the population.[242] Researchers may not know anything about the form of the distribution, or researchers may know something about the form of the distribution but not specific parameter values of the distribution. This lack of knowledge can affect researchers' decisions in many different ways.[243]

Researchers use statistical inference to characterize the probability distribution that generates the data.[244] Given samples drawn from an unknown population distribution, researchers make inferences about what is the form of the distribution.[245] Statistical inference may take the form of estimation, construction of intervals that reflect a particular level of confidence, and hypothesis testing.[246]

Even if researchers learn something about the population distribution, they still may not know the distribution with certainty.[247] Thus, the process of experimentation and statistical inference does not fully eliminate uncertainty. The uncertainty can be described using probability, but even these probabilities may not be known with accuracy.[248]

Discovery uncertainty refers to lack of knowledge about the future discoveries of other researchers. This reflects not only uncertainty about the outcome of particular experiments but also uncertainty regarding the types of experiments undertaken by other researchers and professional interactions among researchers. Researchers benefit from the past discoveries of others. As Isaac Newton wrote, "If I have seen further, it

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242. *See* LARRY WASSERMAN, ALL OF STATISTICS: A CONCISE COURSE IN STATISTICAL INFERENCE 87 (2013), http://static.stevereads.com/papers_to_read/all_of_statistics.pdf.

243. *See* Martin Weber & Colin Camerer, *Recent Developments in Modelling Preferences Under Risk*, 9 OPERATIONS-RESEARCH-SPEKTRUM 129 (1987); *see generally* Colin Camerer & Martin Weber, *Recent Developments in Modeling Preferences: Uncertainty and Ambiguity*, 5 J. OF RISK & UNCERTAINTY 325 (1992) (providing examples of useful surveys).

244. *See* WASSERMAN, *supra* note 242, at 5.

245. *Id.* at 90.

246. *Id.*

247. *See* David Dequech, *Fundamental Uncertainty and Ambiguity*, 26 E. ECON. J. 41, 50–51 (2000) ("Going beyond situations of ambiguity, members of different schools of heterodox economic thought have emphasized situations of uncertainty of a more radical type. These situations are essentially characterized by the possibility of creativity and structural change and therefore by significant indeterminacy of the future. Uncertainty appears here in a dynamic context, in which the passage of time is crucial. The future cannot be anticipated by a fully reliable probabilistic estimate because *the future is yet to be created*.").

248. *Id.*; *see generally* JOHN MAYNARD KEYNES, TREATISE ON PROBABILITY (1921), https://archive.org/stream/treatiseonprobab007528mbp#page/n105/mode/2up/search/uncertainty.

is by standing on the shoulders of giants."[249] However, new discoveries will support or refute past discoveries. This effect compounds the statistical uncertainty researchers face when carrying out a particular project because the outcome of many other projects will impact the value of their work.

Science proceeds through discoveries that may confirm, extend, or refute previous discoveries. Thomas Kuhn argues that the development of scientific knowledge depends on a series of contentious revolutions.[250] Each area of scientific inquiry goes through phases associated with dominant conceptual paradigms during which "normal-scientific research is directed to the articulation of those phenomena and theories that the paradigm already supplies."[251] As Kuhn observes:

> Discovery commences with the awareness of anomaly, i.e., with the recognition that nature has somehow violated the paradigm-induced expectations that govern normal science. It then continues with a more or less extended exploration of the area of anomaly. And it closes only when the paradigm theory has been adjusted so that the anomalous has become the expected.[252]

Israel Scheffler questions the revolution metaphor, emphasizing instead the scientific evaluation of evidence: "The *quality* of scientific deliberations makes for a special and rare form of argumentation. It demands responsibility to the evidence, openness to argument, commitment to publication, loyalty to logic, and an admission, in principle, that one may turn out to be wrong."[253]

Whether through contentious revolutions or reasoned debate, new scientific discoveries cause researchers to reevaluate past discoveries. It is not feasible for ICs to address such complex contingencies. ICs for delegated or cooperative research are necessarily incomplete. IC design and legal rules thus need to provide general incentives for performance under discovery uncertainty.

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249. Letter from Isaac Newton to Robert Hooke (Feb. 5, 1675) (on file with the Historical Society of Pennsylvania Digital Library), https://digitallibrary.hsp.org/index.php/Detail/objects/9792.

250. THOMAS S. KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS 2 (2d enlarged ed., 1970).

251. *Id.* at 24.

252. *Id.* at 52–53.

253. Israel Scheffler, *Vision and Revolution: A Postscript on Kuhn*, 39 PHIL. SCI. 366, 374 (1972).

Creativity uncertainty refers to the lack of knowledge about what other inventors and innovators will develop. It is difficult, if not impossible, to predict the outcomes of invention and innovation.[254] The limitless variety of creativity that is evident in the arts, such as music or literature, extends to invention and innovation in commerce, science, and technology. The creations of inventors and innovators inspire future creativity, further complicating uncertainty.

The creativity of inventors and innovators affects the economic value of past inventions and innovations. Inventions and innovations generate technological change that can enhance or diminish the past contributions of inventors, innovators, and adopters. Just as with discovery uncertainty, it is difficult, if not impossible, for an IC to address contingencies based on the creativity of other inventors and innovators. IC rules must therefore address the complexities of inventor and innovator creativity.

The creativity of other economic actors affects the expectation interests of parties to an IC in unpredictable ways. Advances in technology can serve as complements for existing technology and improve the performance of existing inventions and innovations. For example, advances in software can improve the demand for computer hardware.[255] Conversely, advances in technology can be substitutes for existing technology, leading to its obsolescence. For example, smart phones have displaced basic mobile phones. This corresponds to Joseph Schumpeter's concept of "creative destruction."[256]

The novel and non-obvious criteria for the patentability of an invention illustrate creativity uncertainty.[257] Novelty and non-obviousness are fleeting. An invention is a new and useful production process, machine, manufacturing technique, or composition of matter.[258] Patents are granted for novel inventions, but novelty is not a guarantee of market value because new technologies can readily supersede a patent long before it expires.[259] Obviousness is also subject to fundamental uncertainty. Based on experiments, Gregory Mandel observes:

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254. David Dequech, *Expectations and Confidence Under Uncertainty*, 21 J. POST KEYNESIAN ECON. 415, 416 (1999).

255. EUROPEAN PATENT OFFICE & HANDELSBLATT RESEARCH INST., PATENTS AND THE FOURTH INDUSTRIAL REVOLUTION: THE INVENTIONS BEHIND DIGITAL TRANSFORMATION 20 (2017), https://documents.epo.org/projects/babylon/eponet.nsf/0/17FDB5538E87B4B9C12581EF0045762F/$File/fourth_industrial_revolution_2017__en.pdf.

256. JOSEPH SCHUMPETER, CAPITALISM, SOCIALISM, AND DEMOCRACY 83 (Routledge 2006) (1942).

257. 25 U.S.C. §§ 102–03 (2018).

258. 35 U.S.C. § 101 (2018).

259. Suzanne Scotchmer & Jerry Green, *Novelty and Disclosure in Patent Law*, 21 RAND J. ECON. 131, 146 (1990).

> The results are dramatic: the hindsight bias prejudices patent decisions far more than anticipated. Not only are patent decisions routinely and unintentionally made in contradiction to patent doctrine, but even more significantly, patent law itself is incoherent. Judges, jurors, and patent examiners seemingly lack the cognitive ability to make decisions in the manner that patent law currently requires.[260]

Private agreements fill in many of the gaps left by public awards of IP and judicial decisions on patent validity. IC rules and the design of agreements can address the creativity effects of technological change. ICs reflect the parties' expectations and respond to their perceptions of what is new or obvious. The parties to an IC are better placed to evaluate how the creativity of others will affect their economic benefits. ICs handle much of what happens after the grant of IP.

Market uncertainty refers to unknown demand and costs, which can be heightened by the effects of technological change. We do not know what the demand for inventions will be in advance, particularly when the inventions have not been fully developed or tested. It is difficult, if not impossible, to predict the demand for innovations because they are new to the market. Some innovations, such as smart phones, diffuse rapidly and change the economy, and yet other innovations may be unsuccessful. It is also difficult for companies to estimate how adopting innovations will affect their costs and revenues. Additionally, companies face difficulties predicting competitor innovations and the effects that those innovations will have on market outcomes.

Market uncertainty represents fundamental uncertainty. It is difficult to determine market demand and supply because knowledge about demand and costs is dispersed among individual consumers and firms. Friedrich Hayek observes that society's economic problem is "the utilization of knowledge not given to anyone in its totality."[261] Hayek emphasizes that "the sort of knowledge with which I have been concerned is knowledge of the kind which by its nature cannot enter into statistics and therefore cannot be conveyed to any central authority in statistical form."[262] For Hayek, prices help to coordinate transactions by making the best use of dispersed knowledge.[263] The price system is essential as an

260. Gregory N. Mandel, *Patently Non-Obvious: Empirical Demonstration that the Hindsight Bias Renders Patent Decisions Irrational*, 67 OHIO ST. L.J. 1391, 1393 (2006).

261. F. A. Hayek, *The Use of Knowledge in Society*, 35 AM. ECON. REV. 519, 520 (1945).

262. *Id.* at 524.

263. *Id.* at 526.

adjustment mechanism: "It is, perhaps, worth stressing that economic problems arise always and only in consequence of change."[264]

Hayek argues that market uncertainty presents even greater difficulties than scientific uncertainty.[265] This is because market outcomes are fleeting and lack the relatively greater stability of scientific discoveries:

> The difference between economic competition and the successful procedure of science is that the former exhibits a method of discovering particular temporary circumstances, while science seeks to discover something often known as "general facts," i.e., regularities in events, and is concerned with unique, particular facts only to the extent that they tend to refute or confirm its theories.[266]

Because of market uncertainty, Hayek observes that "competition is important primarily as a discovery procedure whereby entrepreneurs constantly search for unexploited opportunities that can also be taken advantage of by others."[267]

The need to coordinate transactions becomes even more important when dealing with invention, innovation, and adoption. Market uncertainty has greater effects with technological change because inventions and innovations are untested. This makes ICs the essential means of addressing dispersed knowledge and adjusting to technological change.

III. INTELLECTUAL CONTRACT TYPES

ICs protect the expectation interests of parties involved in technological change, including inventors, innovators, and adopters. This section considers various types of IC, including employment contracts, outsourcing contracts, licensing contracts, research joint ventures, and intermediary and collective rights organizations.

A. *Employment Contracts*

Companies hire specialized personnel to carry out invention, innovation, and adoption. Employment contracts between firms and specialized personnel are an important form of IC. Firms use ICs with

264. *Id.* at 523.
265. *Id.* at 523–24.
266. F. A. Hayek, *Competition as a Discovery Procedure*, 5 Q. J. AUSTRIAN ECON. 9, 11 (Marcellus S. Snow trans., 2002) (1968).
267. *Id.* at 18.

managers and employees to create new products, production processes, transaction methods, and organizations.[268]

Most R&D is a delegated activity. R&D refers to basic research, applied research, and experimental development.[269] R&D is the process of discovery and knowledge creation. Designing employment contracts for delegated R&D can be challenging because R&D generates both explicit and tacit knowledge. Tacit knowledge can be difficult and costly to observe, transfer, and reproduce.[270]

Annual expenditures on R&D in the US exceed one-half trillion dollars.[271] Industry provides the main source of this funding ($347.7 billion); the other sources are the federal, state, and local governments ($140.2 billion), academia ($19.3 billion), and non-profits ($20.3 billion).[272] R&D is performed primarily by industry ($366.8 billion), with other R&D being carried out by academia ($75.2 billion), government agencies ($62.7 billion), and non-profits ($22.8 billion).[273]

Just as firms have production functions for goods and services, firms also have production functions for knowledge.[274] The knowledge production function describes how a firm uses R&D investment and employment to create intangible assets. The knowledge production function applies to creation of knowledge by a single firm or by groups of firms.[275] Firms produce intangible assets including various types of IP: patents, trademarks, copyrights, and trade secrets. Intangible assets also

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268. ORG. FOR ECON. COOPERATION AND DEV. & STATISTICAL OFFICE OF THE EUROPEAN CMTYS., OSLO MANUAL: GUIDELINES FOR COLLECTING AND INTERPRETING INNOVATION DATA 16–17 (3d ed. 2005) ("The Manual defines four types of innovations that encompass a wide range of changes in firms' activities: product innovations, process innovations, organisational innovations and marketing innovations."); *see generally* Stephen Bryan et al., *CEO Stock-Based Compensation: An Empirical Analysis of Incentive-Intensity, Relative Mix, and Economic Determinants*, 73 J. BUS. 661 (2000) (discussing contracts with executives).

269. ORG. FOR ECON. COOPERATION AND DEV., FRASCATI MANUAL 2015: GUIDELINES FOR COLLECTING AND REPORTING DATA ON RESEARCH AND EXPERIMENTAL DEVELOPMENT 45 (2015), https://www.oecd-ilibrary.org/docserver/9789264239012-en.pdf?expires=1541275882&id=id&accname=guest&checksum=C5F78E17C5D5D32FCCC469D632ACF256 ("The term R&D covers three types of activity: basic research, applied research and experimental development.").

270. *Id.* at 28 ("For an activity to be an R&D activity, it must satisfy five core criteria. The activity must be: novel, creative, uncertain, systematic, transferable and/or reproducible.").

271. *See 2017 Global R&D Funding Forecast*, R&D MAG., Winter 2017, at 7, https://edisciplinas.usp.br/pluginfile.php/3378934/mod_resource/content/1/RD%202016.pdf ("For 2017, total U.S. R&D spending is expected to increase by 2.9% to $527.5 billion or a 1% increase after accounting for 2017's expected 1.9% inflation rate (EIU/OECD).").

272. *Id.*

273. *Id.*

274. *See* Zvi Griliches, *Issues in Assessing the Contribution of Research and Development to Productivity Growth*, 10 BELL J. ECON. 92, 94–95 (1979).

275. *Id.*; *see also* Adam B. Jaffe, *Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits and Market Value*, 76 AM. ECON. REV. 984, 989 (1986).

include reports of research results, statistical studies, scientific journal articles, software, blueprints, and invention prototypes. Firms produce inventions by employing researchers who have particular skill, judgment, motivation, creativity, and education. Firms invest in laboratory facilities and equipment. A firm may also apply a stock of intangible assets and licensing to produce intangible assets.

Employment contracts protect the interests of managers and employees who devote effort to R&D. Employment contracts must provide incentives for researchers to devote efficient effort to R&D, to make efficient decisions, and to report information accurately.[276] Also, ICs for invention must address who owns the resulting inventions if R&D is successful.

Employment contracts also protect the expectation interests of employers. Firms provide wages and salaries, employee benefits, and training; invest in intangible assets, capital equipment, facilities, and complementary resources; and engage in procurement, marketing, sales, production, and distribution. Employment contracts must provide incentives for firms to hire specialized personnel and invest in technological change.

Companies commonly have significant numbers of employment contracts with research personnel. The Business R&D and Innovation Survey (BRDIS) estimates that there are about 1.5 million R&D workers in the U.S.;[277] these employees include scientists, engineers, R&D managers, and support staff.[278] Brandon Shackelford and Francisco Moris state:

> Scientists and engineers are the researchers responsible for the design and creation of experiments, theories, and new products, processes, or methods. Technicians and other support staff typically work under the supervision of scientists and engineers and perform tasks such as computer programming, carrying out experiments, preparing statistical analysis, and clerical support and report writing.[279]

According to Donald Hecker:

> High-technology occupations are scientific,

276. *See* Myerson, *supra* note 214.

277. Brandon Shackelford and Francisco Moris, NAT'L SCI. FOUND.: NAT'L CTR. FOR SCI. AND ENG'G STATISTICS, A SNAPSHOT OF BUSINESS R&D EMPLOYMENT IN THE UNITED STATES 1 (2016), https://www.nsf.gov/statistics/2017/nsf17302/nsf17302.pdf.

278. *Id.*

279. *Id.*

> engineering, and technician occupations, the same group of occupations used to define high-tech industries in this and earlier studies. They include the following occupational groups and detailed occupations: computer and mathematical scientists, Standard Occupational Classification (soc) 15-0000; engineers, soc 17–2000; drafters, engineering, and mapping technicians, soc 17–3000; life scientists, soc 19–1000; physical scientists, soc 19–2000; life, physical, and social science technicians, soc 19–4000; computer and information systems managers, soc 11–3020; engineering managers, soc 11–9040; and natural sciences managers, soc 11–9120.[280]

The use of ICs for in-house R&D and outsourcing is not a new phenomenon. David Mowery examines industrial research between 1900 and 1940 and observes the growth of R&D both within manufacturing companies and in a network of independent research organizations.[281] Mowery finds that "[r]ather than functioning as substitutes, the independent and in-house research laboratories were complements during this period, exhibiting a division of labor in the performance of research tasks."[282] Division of labor in the performance of research tasks among firms allows firms to specialize and gain greater expertise in particular areas of invention and innovation.[283]

Innovative firms must hire and motivate highly skilled managers and employees.[284] Companies engaged in technological change offer specialized employee contracts and human resources management (HRM) policies.[285] ICs for R&D managers and employees are likely to differ from other types of employment contracts. Pedro Ortín Ángel and Lluís Santamaria Sánchez argue that firms' HRM practices must adapt to the particular needs of their R&D departments.[286] They conduct case studies that examine various HRM practices in R&D, including the delegation of authority to specialized personnel, the provision of managerial support, the formation of multidisciplinary teams, internal

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280. Daniel E. Hecker, *High-Technology Employment: A NAICS-Based Update*, MONTHLY LAB. REV. 57, 58 (2005).

281. David C. Mowery, *The Relationship Between Intrafirm and Contractual Forms of Industrial Research in American Manufacturing, 1900–1940*, 20 EXPLORATIONS IN ECON. HIST. 351 (1983).

282. *Id.* at 369.

283. *See id.* at 369–70.

284. Andersson et al., *supra* note 218, at F326.

285. Pedro Ortin Ángel & Lluís Santamaria Sánchez, *R&D Managers' Adaptation of Firms' HRM Practices*, 39 R&D MGMT. 271, 271 (2009).

286. *Id.*

and external networking opportunities, adjustment of recruitment policies, job rotation, career development, and compensation.[287] Kathryn Martell and Stephen Carroll suggest firms' incentives for R&D personnel follow "promotion and pay policies that are congruent with employee expectations and company goals."[288]

Firms apply ICs to address the assignment of IP generated through the employment relationship. This represents a historical shift toward greater use of contracts.[289] Catherine Fisk notes: "The law of employee inventions is an unstable mixture of the two bodies of law, the former honoring the rights of the *inventor* as employee, the latter being skeptical of the rights of the *employee* as inventor."[290] From 1830 to 1930, Fisk recounts the change in law from an IP regime, in which the employee owns inventions, to a combination of employment contracts that assign inventions to the employer and state laws that include "shop rights" for employers.[291]

Robert Merges examines the role of IP in employment contracts.[292] Merges observes that "[o]wnership is too blunt an instrument to be an effective inducement to employee-inventors."[293] Based on economic analysis, Merges argues that "the law properly allows employers to take ownership of their employees' inventions."[294] Employment contracts provide rewards for employees, specify employee duties, and allocate inventions:

> [E]mployers have broad powers—consistently upheld by the courts—to claim employee inventions by contract. In addition, these contracts usually impose several related duties on employees, including (1) a duty to assign patent applications and patents to the employer, (2) a duty to assist in the patent prosecution, and (3) a general duty to

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287. *Id.* at 284.

288. Kathryn D. Martell & Stephen J. Carroll Jr., *The Role of HRM in Supporting Innovation Strategies: Recommendations on How R&D Managers Should Be Treated from an HRM Perspective*, 25 R&D MGMT. 91, 92 (1995).

289. Catherine L. Fisk, *Removing the "Fuel of Interest" from the "Fire of Genius": Law and the Employee-Inventor, 1830-1930*, 65 U. CHI. L. REV. 1127, 1174 (1998).

290. *Id.* at 1128.

291. *Id.* at 1130–31 ("[M]ost employees who invent are bound by contracts requiring them to assign the patents to their employers.").

292. Robert P. Merges, *The Law and Economics of Employee Inventions*, 13 HARV. J.L. TECH. 1 (1999).

293. *Id.* at 37.

294. *Id.* at 3.

> cooperate in the perfection of the employer's rights in the invention.[295]

Merges also considers three types of default rules under state law.[296] First, when employees engage in "invention for hire," the firm owns the invention.[297] Second, when non-R&D employees engage in firm-related invention, the employee may own the invention while the firm obtains a royalty-free license as a "shop right."[298] Third, when employees engage in independent invention, they generally own the invention.[299] Regarding employee exit, Merges concludes "both the default rules and the interpretation of post-employment contracts favor ex-employees."[300]

Employment contracts with specialized researchers are subject to asymmetric information. The firm may not be able to observe fully the employee's knowledge and skills. Also, it may be difficult for the firm to observe the experimental design and research activities of specialized employees. Then, ICs are subject to Principal-Agent problems in contract design.[301] Companies design ICs to provide performance incentives to specialized managers and employees engaged in invention and innovation.[302]

B. *Outsourcing Contracts*

Companies also use ICs to outsource invention and innovation to specialized research firms. Shackelford and Moris observe that the scientific R&D services industry is "dominated by contract research organizations that assist pharmaceutical, biotechnology, and medical device companies with clinical trials management."[303] They find that the R&D services industry "employs relatively more technicians and support staff as a share of its domestic R&D employment than do most other industries."[304] Firms contract with "star scientists" for access to knowledge and IP.[305] In-house R&D is complementary to outsourcing

295. *Id.* at 8.
296. *Id.* at 5.
297. *Id.* at 5–6.
298. *Id.* at 6.
299. *Id.* at 6–7.
300. *Id.* at 47.
301. *Id.* at 26–27.
302. *See* Poblete & Spulber, *supra* note 39.
303. Shackelford & Moris, *supra* note 277, at 1.
304. *Id.*
305. Nicola Lacetera et al., *Do Firms Change Capabilities by Hiring New People? A Study of the Adoption of Science-Based Drug Discovery*, 21 ADVANCES STRATEGIC MGMT. 133 (2004); Lynne G. Zucker et al., *Commercializing Knowledge: University Science Knowledge Capture, and Firm Performance in Biotechnology*, 48 MGMT. SCI. 138 (2002).

R&D because internal knowledge helps the firm absorb external knowledge.

ICs that outsource R&D to a specialized research firm may face problems of moral hazard and adverse selection.[306] The firm may compensate the specialized research firm based on some measure of invention or innovation, including revenues or profits.

Many companies outsource various invention and innovation activities.[307] Paul Trott and Dap Hartmann find that "R&D departments have long recognised the importance of information and knowledge beyond their own organizations."[308] Companies rely on many types of strategic alliances, including "licensing, supplier relations, outsourcing, joint venture, collaboration (non-joint ventures), R&D consortia, industry clusters, and innovation networks."[309] Henry Chesbrough and others describe a trend toward increasing R&D cooperation among firms as "open innovation."[310]

It is estimated that companies obtain about half of their innovations from outside sources.[311] Contracting to obtain R&D services from other firms is complementary to the firm's internal R&D.[312] For example, internal R&D increases a firm's absorptive capacity for external knowledge.[313]

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306. Poblete & Spulber, *supra* note 39, at 39 ("Companies and government agencies also outsource R&D by contracting with research laboratories, specialized firms, universities, and independent researchers. . . . Corporations and venture capitalists also engage in delegation of R&D through financing, monitoring, and directing entrepreneurial technology startups, specialized research firms, and independent researchers.").

307. Reinhilde Veugelers, *Internal R&D Expenditures and External Technology Sourcing*, 26 RES. POL'Y 303, 308 (1997); Peter Teirlinck et al., *Corporate Decision-Making in R&D Outsourcing and the Impact on Internal R&D Employment Intensity*, 19 INDUS. CORP. CHANGE 1741, 1742 (2010).

308. Paul Trott & Dap Hartmann, *Why 'Open Innovation' is Old Wine in New Bottles*, 13 INT'L J. INNOVATION MGMT. 715, 716 (2009).

309. *Id.* at 720.

310. Henry W. Chesbrough, *The Era of Open Innovation*, MIT SLOAN MGMT. REV., Spring 2003, at 35; Henry W. Chesbrough, *Why Companies Should Have Open Business Models*, MIT SLOAN MGMT. REV., Winter 2007, at 22.

311. Ashish Arora et al., *The Acquisition and Commercialization of Invention in American Manufacturing: Incidence and Impact*, 45 RES. POL'Y 1113, 1113 (2016) ("Our results indicate that, between 2007 and 2009, 16% of manufacturing firms had innovated—meaning had introduced a product that was new to the industry. Of these, 49% report that their most important new product had originated from an outside source, notably customers, suppliers and technology specialists (i.e., universities, independent inventors and R&D contractors).").

312. Ashish Arora and Alfonso Gambardella, *The Market for Technology*, *in* 1 HANDBOOK OF THE ECONOMICS OF INNOVATION 641, 651 n.8 (Bronwyn H. Hall and Nathan Rosenberg eds., 2010).

313. Wesley M. Cohen and Daniel A. Levinthal, *Innovation and Learning: The Two Faces of R&D*, 99 ECON. J. 569, 589 (1989).

About four-fifths of world trade moves through a global supply chain involving networks of suppliers, distributors, and intermediaries.[314] The organization of production through global supply chains often involves contracts for outsourcing invention and innovation to supply chain managers and specialized research companies.[315] For example, pharmaceutical companies outsource clinical trials to Contract Research Organizations (CROs).[316]

C. *Joint Venture and Consortium Contracts*

Firms use contracts to form RJVs and R&D consortia.[317] These are important types of IC. As with any joint venture, the RJV can take the form of a jointly-owned corporation, partnership, or contract without equity.[318] RJVs and consortia allow companies to cooperate in R&D while continuing to compete in product markets.[319] Joint ventures are an alternative to expansion of the firm through growth or mergers and acquisitions (M&A).[320] Klaus Gugler and Ralph Siebert find that in the semi-conductor industry, RJVs tend to achieve greater efficiency gains than M&A.[321]

Firms form R&D joint ventures and consortia to share the costs and risks of R&D.[322] By combining projects, the R&D joint venture can realize economies of scale in R&D, including specialization of function and division of labor for researchers. The firms may benefit from

314. *See* WORLD TRADE ORG., WORLD TRADE REPORT 2014: TRADE AND DEVELOPMENT: RECENT TRENDS AND THE ROLE OF THE WTO 43 (2014).

315. Jeremy Howells et al., *The Growth and Management of R&D Outsourcing: Evidence from UK Pharmaceuticals*, 38 R&D MGMT. 205, 206 (2008).

316. Pierre Azoulay, *Capturing Knowledge Within and Across Firm Boundaries: Evidence from Clinical Development*, 94 AM. ECON. REV. 1591, 1591 (2004).

317. For a discussion on JVs, see AM. BAR ASS'N, MODEL JOINT VENTURE AGREEMENT 359–72 (2006), https://apps.americanbar.org/buslaw/newsletter/0049/materials/book.pdf. For a discussion on R&D consortia, see Suzanne E. Majewski, *How Do Consortia Organize Collaborative R&D? Evidence from the National Cooperative Research Act* (Harvard Law Sch. John M. Olin Ctr. Law, Econ., Bus., Discussion Paper No. 483, 2004), http://dx.doi.org/10.2139/ssrn.615583.

318. AM. BAR ASS'N, *supra* note 317.

319. Majewski, *supra* note 317.

320. DELOITTE, A STUDY OF JOINT VENTURES THE CHALLENGING WORLD OF ALLIANCES 2 (2010), https://www2.deloitte.com/content/dam/Deloitte/fr/Documents/finance/Publications/Etude_Joint_Venture_juillet%202010.pdf.

321. Klaus Gugler and Ralph Siebert, *Market Power Versus Efficiency Effects of Mergers and Research Joint Ventures: Evidence from the Semiconductor Industry*, 89 REV. ECON. STAT. 645, 651 (2007).

322. *See* James A. Dobkin, *Negotiating an International Technology Joint Venture*, 1 CONN. J. INT'L L. 81, 83 (1985); Joanna Poyago-Theotoky, *Equilibrium and Optimal Size of a Research Joint Venture in an Oligopoly with Spillovers*, 43 J. INDUS. ECON. 209, 209 (1995).

combining complementary skills and knowledge in R&D. Firms also may cooperate in R&D because it may be difficult to exclude access to each other's R&D. By combining R&D projects, the firms will appropriate the benefits of the knowledge created, thus internalizing potential spillovers that would result from separate projects.[323] The RJV may also facilitate various business relationships, including agreements between suppliers and customers.[324]

The partners in an RJV may not be able to observe each other's R&D efforts or knowledge, which would lead to moral hazard and adverse selection problems. Addressing these problems requires dividing the benefits of the partnership based on some measure of performance. It may not be feasible to design an IC that induces sufficient R&D effort to maximize the joint benefits of the parties.[325] Licensing arrangements affect the incentives of partners to share IP with the RJV.[326]

The National Cooperative Research Act (NCRA) of 1984 and the National Cooperative Research and Production Act (NCRPA) in 1993 limit antitrust liability for members of R&D consortia.[327] These consortia report their membership to the Department of Justice (DOJ) and the

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323. According to Yannis Caloghirou et al.:

> Company incentives to join an RJV may include one or more of the following:
> 1. R&D cost sharing;
> 2. Reduction of R&D duplication;
> 3. Risk sharing, uncertainty reduction;
> 4. Spillover internalisation;
> 5. Continuity of R&D effort, access to finance;
> 6. Access of complementary resources and skills;
> 7. Research synergies;
> 8. Effective deployment of extant resources, further development of resource base;
> 9. Strategic flexibility, market access, and the creation of investment 'options';
> 10. Promotion of technical standards;
> 11. Market power, co-opting competition;
> 12. Legal and political advantages.

Yannis Caloghirou et al., *Research Joint Ventures*, 17 J. ECON. SURV. 541, 556 (2003).

324. Nicholas S. Vonortas, *Research Joint Ventures in the U.S.*, 26 RES. POL'Y 577, 591 (1997).

325. *See* Bengt Holmstrom, *Moral Hazard in Teams*, 13 BELL J. ECON. 324, 325 (1982); Karl Morasch, *Moral Hazard and Optimal Contract Form for R&D Cooperation*, 28 J. ECON. BEHAV. & ORG. 63, 65 (1995).

326. Sudipto Bhattacharya et al., *Licensing and the Sharing of Knowledge in Research Joint Ventures*, 56 J. ECON. THEORY 43, 44 (1992).

327. National Cooperative Research and Production Act of 1993, 15 U.S.C. §§ 4301–06 (2018); National Cooperative Research Act of 1984, 15 U.S.C. §§ 4301–05 (1984) (current version at 15 U.S.C. §§ 4301–06 (2018)).

Federal Trade Commission (FTC).[328] From 1984 to 2008, 942 joint ventures registered with the antitrust agencies.[329] The RJV may reduce competition between the partners but increase competition between the partners and other firms in the industry.[330]

Almost all joint ventures, even if they are not RJVs, involve parent companies licensing or transferring technology to the venture.[331] Kurt Saunders cautions that negotiation and planning of the RJV should address the disclosure, ownership, use, and management of IP contributed to or created by the venture.[332] The RJV agreement should also address the rights and duties of the partners and the joint venture regarding protection of IP, as well as infringement and misappropriation.[333] RJVs can provide contractual protections for intangible assets when there are insufficient patent protections.[334]

D. *License Contracts*

ICs include IP license contracts. These types of contracts have a number of common features.[335] The license contract describes the business relationship between the parties.[336] The license contract specifies the period of time for the grant of rights to the licensee and lists the IP that is covered by the agreement.[337] The contract may place various restrictions on the grant of rights.[338] The Code of Federal Regulations states "the licensing of a patent transfers a bundle of rights which is less than the entire ownership interest, e.g., rights that may be limited as to time, geographical area, or field of use."[339] The licensing contract addresses IP issues that arise when either of the parties makes

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328. Yves L. Doz et al., *Formation Processes of R&D Consortia: Which Path to Take? Where Does It Lead?*, 21 STRATEGIC MGMT. J. 239, 240 (2000).

329. *See* Majewski, *supra* note 317.

330. Janusz A. Ordover and Robert D. Willig, *Antitrust for High Technology Industries: Assessing Research Joint Ventures and Mergers*, 28 J. L. ECON. 311, 313–14 (1985).

331. Jordan, *supra* note 71, at 10.

332. Kurt M. Saunders, *The Role of Intellectual Property Rights in Negotiating and Planning a Research Joint Venture*, 7 MARQ. INTELL. PROP. L. REV. 75, 97 (2003).

333. *Id.* at 95.

334. Roberto Hernán et al., *An Empirical Evaluation of the Determinants of Research Joint Venture Formation*, 51 J. INDUS. ECON. 75, 87 (2003).

335. *See* DONALD M. CAMERON & ROWENA BORENSTEIN, KEY ASPECTS OF IP LICENSE AGREEMENTS 8 (2003), http://www.jurisdiction.com/lic101.pdf.

336. *Id.* at 7.

337. *Id.* at 32.

338. *Id.* at 12.

339. USPTO, MANUAL OF PATENT EXAMINING PROCEDURE (MPEP) § 301 (9th ed. 2015), https://www.uspto.gov/web/offices/pac/mpep/s301.html#d0e17687.

improvements to the technology.[340] The contract also specifies the IP holder's compensation, including the way that royalties are calculated.[341]

Most IP license contracts are specific to the business relationship between the licensor and the licensee.[342] This implies that most IP license contracts require bilateral negotiation that tailors the agreement to the needs of the relationship.[343] License contracts offered by patent pools are an exception because they have standardized provisions and royalties.[344]

An IP license contract is designed to maximize the joint returns of the licensor and licensee.[345] The most basic license gives the licensee access to the licensor's intangible assets.[346] These licenses can serve to avoid litigation or resolve a dispute over IP.[347] More complicated ICs involve additional business arrangements, including invention, innovation, investment, marketing, and complementary assets.[348]

License contracts may provide incentives for inventors to develop and transfer the invention and for adopters to apply the invention. The

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340. CAMERON & BORENSTEIN, *supra* note 335, at 21 ("There is no widely accepted definition for 'improvement' in the context of intellectual property licenses, but it is usually used to mean a development within the field of the licensed technology that enhances the usability, functionality, efficiency, performance or other characteristic of the original technology.").

341. *See generally id.* (stating the contract also includes representations and warranties, disclaimers and limitations of liability, conflict resolution, contract termination and renewal, and enforceability).

342. Raymond C. Nordhaus, *Patent License Agreements*, 21 BUS. LAW. 643, 643 (966) ("Because of the infinite variety of rights and obligations that may be established between a patent licensor and his licensee, there is no 'standard' form of license agreement that may be used in all situations. Each license agreement must be carefully tailored to the specific circumstances of the particular case."); Bharat N. Anand and Tarun Khanna, *The Structure of Licensing Contracts*, J. INDUS. ECON. 103, 131 (2000) ("Licensing contracts in the Computer and Electronics industries are more likely to be signed with firms with whom the licensor has prior relationships, established either through alliance activity, common board membership, or personnel histories.").

343. *See* Daniel F. Spulber, *Patent Licensing and Bargaining with Innovative Complements and Substitutes*, 70 RES. ECON. 693, 695 (2016).

344. *See id.* at 710.

345. *Id.* at 693.

346. Michael L. Katz and Carl Shapiro, *How to License Intangible Property*, 101 Q. J. ECON. 567, 568 (1986).

347. Sanford E. Warren Jr., *Intellectual Property Litigation Rising: How to Protect Your Company's Financial Health*, IRMI (Sept. 2009), https://www.irmi.com/articles/expert-commentary/intellectual-property-litigation-rising-how-to-protect-your-company-s-financial-health.

348. The demand for licenses is based on "carrots" if the user derives benefits from using the intangible asset. The demand for licenses is based on "sticks" if the user obtains the license to avoid litigation over disputed technology. Finally, the demand for licenses is based on "bundles" if the user obtains the license because it is included in a bundle with complementary goods and services. *See* Niklas Östman, *How to Create the 'Pull' for Patent Licensing?*, LINKEDIN (Sept. 6, 2016), https://www.linkedin.com/pulse/how-create-pull-patent-licensing-niklas-%C3%B6stman?trk=prof-post.

Principal-Agent problem involving hidden action or hidden information arises in licensing contracts.[349] Richard Jensen and Marie Thursby study university licensing agreements and find most include both fixed fees and royalties; many also include sponsored research clauses and equity.[350] The university licensing agreement with potential licensees involves a stage in which researchers continue to develop an invention.[351] This is a moral hazard problem because research efforts are not observable to the licensee. The licensing contract includes running royalties intended to induce inventor effort and lump-sum royalties that reflect potential earnings from commercialization of the invention.[352] Daniel Elfenbein considers university licensing agreements and observes the incidence of royalties based on sales, lump-sum license fees, milestones, maintenance fees and minimums, and equity.[353]

Inventors often have tacit knowledge that is complementary to their intangible assets. Inventors incur costs of codifying and communicating their knowledge to technology adopters.[354] When it is very costly to transmit the inventor's knowledge, the inventor may have an advantage in applying that knowledge in comparison to technology adopters. Technology adopters may have advantages in applying the technology resulting from their own knowledge and complementary assets. This can overcome the problem of transmitting the inventor's tacit knowledge, resulting in technology transfers.[355] Deepak Hegde explores how tacit knowledge affects the structure of royalties in licensing contracts, including royalty rates, lump-sum fees, milestones and minimum payments.[356]

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349. *See* Inés Macho-Stadler et al., *The Role of Information in Licensing Contract Design*, 25 RES. POL'Y 43, 52 (1996) (discussing the role of information in determining the structure of royalties in patent licensing contracts); *see also* Nancy T. Gallini and Brian D. Wright, *Technology Transfer under Asymmetric Information*, 21 RAND J. ECON. 147 (1990).

350. Richard Jensen and Marie Thursby, *Proofs and Prototypes for Sale: The Licensing of University Inventions*, 91 AM. ECON. REV. 240 (2001).

351. *Id.* at 248.

352. *See id.* at 245.

353. Daniel W. Elfenbein, Contract Structure and Performance of University-Industry Technology Transfer Agreements (July 30, 2009), https://ssrn.com/abstract=1452717.

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

355. *Id.*

356. Deepak Hegde, *Tacit Knowledge and the Structure of License Contracts: Evidence from the Biomedical Industry*, 23 J. ECON. MGMT. STRATEGY 568, 568 (2014).

E. *Platform Contracts*

Firms and cooperative organizations help establish and manage the market for innovative control.[357] Firms and cooperative organizations use platform contracts to reduce transaction costs for both technology providers and technology adopters. Intermediary firms offer transaction efficiencies by market making, matching buyers and sellers, and reducing adverse selection and moral hazard.

Almost all markets are established by profit-maximizing firms acting as intermediaries.[358] Firms provide intermediary services as market makers by purchasing and reselling goods and services.[359] Such firms include retailers, wholesalers, and financial brokers.[360] Market makers clear markets by balancing purchasing and sales and by posting and adjusting prices.[361] Firms also provide intermediary services by acting as matchmakers, bringing buyers and sellers together.[362] Market makers and matchmakers establish the rules of markets, referred to in finance as "market microstructure."[363] The Internet has given rise to platforms, which are digital market places. Intermediary firms that operate digital markets include Amazon, eBay, and Alibaba.

In the market for innovative control, just as in markets generally, there are intermediaries that improve the efficiency of transactions.[364] By handling a high volume of transactions, intermediaries benefit from economies of scale and scope.[365] These economies are due to benefits from sharing fixed costs across many units of output or across multiple products.[366] Economies of scale and scope also result from specialization of function and division of labor among the employees of intermediary firms. A centralized intermediary can realize economies of scale and scope in the management of IP, keeping track of patent renewal fees, monitoring infringement, and defending patents against infringement. The centralized intermediary can provide convenience by licensing patent portfolios as bundles.

357. Daniel F. Spulber, *Market Microstructure and Intermediation*, 10 J. ECON. PERSP. 135, 141 (1996).

358. *Id.* at 135.

359. *Id.*

360. *Id.* at 137–38.

361. *Id.* at 136.

362. *Id.* at 145–46.

363. *Id.* at 135.

364. *Id.* at 146.

365. Spulber, *supra* note 77, at 293.

366. *Id.* at n.168.

Intermediary firms also improve transaction efficiencies by centralizing transactions.[367] Buyers and sellers derive convenience from "one-stop-shopping." A buyer can have access to the products of many sellers and a seller can reach many buyers, but any buyer or seller need only transact with the intermediary. In markets for innovative control, a licensee can obtain licenses for the technology of many licensors and a licensor can provide licenses to many sellers.

There are also transaction efficiencies from platforms that provide centralized contract negotiation.[368] This is because buyers and sellers need only negotiate with the intermediary. This dramatically decreases the number of transaction relationships in comparison to the large number of bilateral transactions needed with decentralized contracting. With centralized contracting, agreements and compensation can be standardized. This allows licensors and licensees to have standardized contracts with the intermediary. This is particularly important in industries that have complex innovations requiring a combination of many different IP licenses.

IP intermediaries use ICs to address non-rivalrous consumption. The same technology can be used simultaneously by many firms to produce new inventions and to develop innovative products, production processes, and transaction methods. IP intermediaries provide central hubs to realize the returns from contracts with many adopters.

IP intermediaries address transaction costs in patent transfers and patent licensing.[369] According to an FTC study of "Patent Assertion Entities," about half of the companies in the study used patent acquisition contracts that shared licensing revenue with the inventor or employer of the inventor.[370] The companies in the study acted as intermediaries between patent holders and licensees.[371]

Some companies acquire patents and provide a "one-stop-shopping" platform for licensees. Consider for example, the patent intermediary Avanci:

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367. Spulber, *supra* note 357, at 145.

368. Daniel F. Spulber, *The Economics of Markets and Platforms*, 28 J. ECON. MGMT. STRATEGY 159, 169–70 (2019).

369. Naomi R. Lamoreaux & Kenneth L. Sokoloff, *Intermediaries in the U.S. Market for Technology, 1870–1920* 28 (Nat'l Bureau of Econ. Research, Working Paper No. 9017, 2002), https://www.nber.org/papers/w9017.pdf; James F. McDonough III, *The Myth of the Patent Troll: An Alternative View of the Function of Patent Dealers in an Idea Economy*, 56 EMORY L.J. 189, 207 (2007).

370. FED. TRADE COMM'N, PATENT ASSERTION ENTITY ACTIVITY: AN FTC STUDY (2016), https://www.ftc.gov/system/files/documents/reports/patent-assertion-entity-activity-ftc-study/p131203_patent_assertion_entity_activity_an_ftc_study_0.pdf.

371. *Id.* at 100; *see also* John E. Dubiansky, *The Licensing Function of Patent Intermediaries*, 15 Duke L. & Tech. Rev. 269, 273 (2017).

> Avanci has created the first platform for IoT manufacturers to license crucial, standard-essential wireless technologies with an emphasis on fair, transparent pricing. Avanci's pricing model offers flat rate royalty calculations that streamline licensing and enable predictable costs to help IoT developers capitalize on a dynamic market opportunity.[372]

Avanci emphasizes the benefits of "one-stop-shopping" and the implications of connectivity:

> Products with wireless connectivity require access to thousands of patented inventions, created by many inventors. Avanci is bringing together standard-essential wireless patents that represent the most advanced wireless technology in the world, in an efficient, one-stop marketplace. So, instead of going to each technology owner to request, negotiate and pay for a license, makers of products for the Internet of Things can get the technology they need in one place.[373]

Avanci points out that transaction efficiencies increase incentives for innovation:

> By providing licenses to essential wireless technology at fair rates, Avanci is helping ensure companies who need connectivity for their products can access it easily, and those creating wireless technology can share it as widely as possible. And both are incentivized to never stop innovating.[374]

IC intermediaries also include cooperative non-profit institutions such as patent pools and other Collective Rights Organizations (CROs).[375] By offering transaction efficiencies, such private contracting institutions help to avoid antitrust scrutiny and government-mandated licensing.[376]

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372. AVANCI, AVANCI: ACCELERATING IOT CONNECTIVITY 2 (2016), http://avanci.com/wp-content/uploads/2017/01/2016-Avanci-WP-Final-_-Jan-24.pdf.

373. *Technology*, AVANCI, http://avanci.com/technology/ (last visited Jan. 21, 2019).

374. *Id.*

375. Robert P. Merges & Michael Mattioli, *Measuring the Costs and Benefits of Patent Pools*, 78 OHIO ST. L.J. 281, 285 (2017) ("The benefit for licensees is easy to appreciate: 'one stop shopping' for many patents at once. This conserves on the cost of licensing numerous patents from dispersed patent holders by, in a sense, compressing that process into a single event.").

376. Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 CALIF. L. REV. 1293, 1295 (1996) ("Collective Rights Organizations (CROs) will often emerge to break the transactional bottleneck. From patent pools to collective copyright licensing organizations such as ASCAP and BMI, IPR owners in various industries have demonstrated the workability of these private transactional mechanisms. Indeed,

Robert Merges argues that "[t]he high costs of contracting—both among members, and between members and users—drive the right holders to pool their property rights in a collective organization."[377]

Patent pools act as intermediaries and provide transaction platforms for patent holders and licensees.[378] Patent pools reduce the transaction costs of combining licenses for complementary inventions.[379] For example, MPEG LA, LLC provided a "one-stop-shopping" platform for licensing patents covering the international digital video compression standard MPEG-2.[380] MPEG LA operated licensing programs covering "thousands of patents owned by hundreds of patent holders in nearly 100 countries with over 6,000 licensees."[381]

CONCLUSION

It has long been observed that "possession is nine-tenths of the law," although there is much more to law than property. Similarly, discussions of knowledge and technological change tend to focus on IP. Yet, there is much more to Intellectual Law than IP.

The Intellectual Law framework introduced in this Article provides a comprehensive framework for dynamic efficiencies in technological change. The present discussion emphasizes that IC rules play an important role in Intellectual Law. ICs protect the expectation interests of those who invest in technological change. ICs allow variation in investment over time as parties make discoveries. IC law provides the basis for creating, developing, sharing, and applying intangible assets needed for technological change. IC rules enhance the economic contributions of both IP and IT rules.

IP provides the foundation of the market for innovative control, but IP is not sufficient for technological change. IP is incomplete and provides limited exclusivity. IP can be subject to public policy shocks that tend to weaken protections for inventors, innovators, and adopters. Also, the IT protections for inventors shift consent from IP owners to infringers. This suggests the need to reconsider the IP versus IT controversy in the context of contributions made by IC.

Technological change requires agreements that induce future performance. Cooperative investment generates invention, innovation, and technology adoption. Firms make these investments based on

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these case studies uncover two distinct advantages of CROs: expert tailoring and reduced political economy problems.").

377. *Id.* at 1302.

378. *Id.* at 1340–42.

379. *Id.* at 1340.

380. Lacy Horn, *Alternative Approaches to IP Management: One-stop Technology Platform Licensing*, 9 J. COM. BIOTECHNOLOGY 119, 120 (2003).

381. MPEGLA, https://www.mpegla.com. (last visited Feb. 16, 2019).

agreements with employees, suppliers, partners, investors, and customers. Technological change based on IC rules promotes economic development and drives economic growth.

ICs differ from standard contracts in various ways. ICs realize the benefits from non-rivalrous usage of technology through such mechanisms as licensing, cross-licensing, RJVs, R&D consortia, and one-stop-shopping platforms. ICs provide incentives for exploratory performance. ICs induce effort and revelation of information by rewarding performance using measures related to technological change. In contrast to contracts for the routine production of goods and services, ICs consider fundamental uncertainty. ICs must handle problems arising when contracting parties' efforts and information are unobservable and unverifiable. Such contracting difficulties are more likely to occur with invention and innovation than with more routine activities. ICs provide incentives for invention, innovation, and adoption. ICs achieve gains from trade in technology, thus increasing the rewards of IP holders beyond what they could achieve through IP alone.

The rate and direction of technological change have increased the shift toward IC. Greater connectivity and exchange of data among firms requires agreements for discovery and sharing knowledge. Increased emphasis of software over hardware means that inventions and innovations are virtual, further increasing the importance of intangible assets. The development of AI requires agreements between firms and employees and among firms to address new forms of knowledge creation. The technological development of the economy is transforming contracts and generating the need for a framework of "Intellectual Law."