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EXPIRED PATENTS

Saurabh Vishnubhakat⁺

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In the last five years, over one-third of a million patents quietly expired for lack of maintenance.¹ The inventions embodied in those patents represent a peculiar balance of resource allocation. On one hand, that they were patented at all suggests these inventions once warranted the development and concretization of research, as well as the financing necessary to prosecute and secure patent rights. However, that they subsequently expired for lack of maintenance reveals that these inventions were eventually not even worth the relatively modest statutory fee needed to keep them in force.² Sunk investments did not yield returns. Perhaps other, more promising inventions took precedence. Regardless, these inventions are now freely available in the public domain to be practiced and improved upon.³

To understand the significance of the public inheritance of the subjects of expired patents, it is useful to understand the nature of that practice and to examine a dataset of expired patents for commonality or patterns. Accordingly, this Article presents a dataset of these recently expired patents to characterize

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1. See *infra* Figures 1–17.

2. See *United States Patent and Trademark Office Fee Schedule*, U.S. PAT. & TRADEMARK OFFICE, <http://www.uspto.gov/web/offices/ac/qs/ope/fee010114.htm#patapp> (last visited Jan. 5, 2014) (listing patent maintenance fee amounts).

3. J. Jonas Anderson, *Secret Inventions*, 26 BERKELEY TECH. L.J. 917, 941 (2011).

them, primarily with respect to technology and geography, as well as to compare them to recently issued patents as a springboard for rigorous empirical research on the evolving balance of innovation in the U.S. economy. Part I contextualizes the value of this new dataset within existing scholarship on the technology- and geography-specific dimensions of patenting activity. Part II explains the construction and usage of the dataset, provides descriptive statistics as well as some preliminary policy-relevant inferences, and presents an outlook for potential future research and analytical refinement enabled by this data.

I. THE WHAT AND THE WHERE OF PATENTS

A. *Technology-Specificity in Patenting*

A live debate persists on whether the U.S. patent system is, and should be (in the words of the National Academy of Sciences (NAS)), a truly “unitary system with few *a priori* exclusions.”⁴ The 2004 NAS Report submitted that it is such a system.⁵ As a result, the report suggested that the U.S. patent system is a strong one because a unitary system contributes to flexibility in the service of accommodating new technologies—a self-evidently desirable driver of innovation.⁶ As the NAS Report clarifies and critics emphasize, however, even a purportedly unitary system is flexible only insofar as it can impose broad standard-like criteria in a technology-agnostic manner without the sacrifice of rule-like virtues (such as certainty, stability, and security⁷) that arise from the application of those standards in contexts that are often quite technology-specific.⁸

Indeed, as a practical matter, much patent doctrine is technology-specific because it premises patentability requirements such as obviousness and enablement upon what a person having ordinary skill in the art (PHOSITA) would have been able to conceive with certain prior knowledge,⁹ or may

4. NAT'L RESEARCH COUNCIL OF THE NAT'L ACADS., A PATENT SYSTEM FOR THE 21ST CENTURY 42 (Stephen A. Merrill et al. eds., 2004) [hereinafter NAS REPORT] (emphasis added).

5. *See id.* at 41.

6. *Id.* (stating that “[a] system granting even temporary monopoly rights to developers of one technology but providing no incentives to developers of other, including substitute, technologies obviously would be hostile to innovation over the long run”). If qualitatively obvious, however, the actual economic harms to innovation attributable to fragmented monopoly-rights regimes, favoring some technologies and industries at the expense of others, remains largely unstudied.

7. *See Pierre Schlag, Rules and Standards*, 33 UCLA L. REV. 379, 400 (1985) (discussing the vices and virtues of rules and standards as a legal dialectic).

8. NAS REPORT, *supra* note 4, at 45–46 (“Notwithstanding its unitary character, the U.S. patent system is differentiated in transparent and subtle ways that accommodate differences in technologies or that affect technologies differently.”).

9. *See* 35 U.S.C. § 103(a) (2012) (denying patent protection for inventions that would have been obvious to “a person having ordinary skill in the art to which the claimed invention pertains”).

subsequently be able to accomplish with certain teaching.¹⁰ This approach of applying unitary legal standards to particular technologies, rather than crafting disparate technology-specific regimes, can have significant retrospective and prospective public policy consequences, particularly with regard to the incentive function of patents.¹¹

Retrospectively, the unitary nature of patentability standards can affect whether the patent incentive operates effectively to recoup investments already sunk into research and development.¹² For example, Professor Jonathan Darrow has argued that application of the PHOSITA standard for obviousness suffers from an overreliance on defining the supposed level of skill and on delineating the scope of relevant prior knowledge against which to judge the invention, while neglecting the ordinarily skilled artisan's perspective within the art.¹³ He traced the history of three major perspectives: the mechanic, a tradesman “who practiced his art with ordinary skill but who was not an inventor[;]”¹⁴ the designer, “whose work required a significant effort of the brain[;]”¹⁵ and the professional researcher.¹⁶ The patent system, he found, has drifted inappropriately toward a researcher-based conception of ordinary skill that systematically under-rewards innovation in the useful arts by defining the relevant art itself in terms of innovative activity.¹⁷

Prospectively, the unitary nature of patentability standards can affect whether, and to what extent, institutional reforms in the patent system can successfully promote incentive-aligned invention (i.e., invention that would not have come about but for the promise of patent protection).¹⁸ Thus, evaluating the

10. See *id.* at § 112(a) (explaining that patent protection requires a written description sufficient to enable the practice of the invention by “any person skilled in the art to which it pertains”).

11. For a succinct discussion of the incentive function that patents are intended to serve, see generally Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 266 (1977) (asserting “[t]he patent is a reward that enables the inventor to capture the returns from his investment in the invention, returns that would otherwise (absent secrecy) be subject to appropriation by others”). See also KENNETH J. ARROW, *ESSAYS IN THE THEORY OF RISK-BEARING* 152 (Julius Margolis ed., 1971) (identifying “a fundamental paradox in the determination of demand for information; its value for the purchaser is not known until he has the information, but then he has in effect acquired it without cost”).

12. See Jonathan J. Darrow, *The Neglected Dimension of Patent Law's PHOSITA Standard*, 23 HARV. J.L. & TECH. 227, 253 (2009) (discussing the importance of patent incentives as a method of reducing investment risk).

13. See *id.* at 237–38.

14. *Id.* at 239–40.

15. *Id.* at 242–43.

16. *Id.* at 243–44.

17. See *id.* at 228 (explaining that “[b]ecause patent law is intended to encourage investment in activities likely to lead to improvements in an art—that is, research—a conception of the PHOSITA as an ‘ordinary researcher’ becomes counterproductive”).

18. Daniel R. Cahoy, *An Incrementalist Approach to Patent Reform Policy*, 9 N.Y.U. J. LEGIS. & PUB. POL'Y 587, 621–22 (2006).

desirability of different aspects of the patent right may require distinguishing the availability of particular rights from the extent of those rights; such unitary protection encourages or discourages invention differently with respect to each.¹⁹ In such a framework, extending the scope of patent-eligible subject matter may encourage incentive-aligned invention where the patent-eligible fields are valuable to society, are in need of investment incentives, and will consequently generate innovative activity on an equal basis with other protected fields.²⁰ However, it may discourage incentive-aligned invention if one of these assumptions fails, particularly when patent protection does not have a significant impact on incentives to innovate.²¹

Similarly important is the extent of different aspects of the patent right, including the breadth of protection that may be claimed, the types of activities over which the patent may be asserted, the duration of the right, and the extent of disclosure necessary to seal the patent bargain.²² For example, the breadth of what may be justified as a “pioneer patent” and its effect on follow-on innovation,²³ particularly when broad patent rights may be granted early in the innovation life cycle to forestall expensive duplication of research,²⁴ differs between industries characterized by a significant amount of follow-on innovation and those in which cumulative innovation is not the norm.²⁵ The impact of a right to exclude without regard for infringer intent,²⁶ albeit a negative right with no positive right to practice one’s own invention,²⁷ differs in industries

19. *See id.* at 610–21 (discussing how legal attributes contribute to the patent incentive structure).

20. *Id.* at 610–11.

21. *Id.* (noting the market may impact the utility of patent incentives).

22. *Id.* at 613.

23. Compare Oren Bar-Gill & Gideon Parchomovsky, *A Marketplace for Ideas?*, 84 TEX. L. REV. 395, 409–10 (2005) (arguing that patents for pioneering inventions inherently create the risk of hold-up with respect to downstream improvements that require access to the original invention), with John F. Duffy, *Rethinking the Prospect Theory of Patents*, 71 U. CHI. L. REV. 439, 489–90 (2004) (disputing the patent policy of allowing pioneers to prevent follow-on innovations from free riding).

24. RICHARD A. POSNER, *ECONOMIC ANALYSIS OF LAW* 46–47 (5th ed. 1998).

25. *See Cahoy, supra* note 18, at 615–16 (noting the benefits and detriments of prolonged patent rights); Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1619–24 (2003) (illustrating a case study of software as an industry of incremental innovation requiring idiosyncratically narrow and short-lived patents).

26. Patent infringement as a strict liability tort is commonplace in case law. *See, e.g.*, *Hilton Davis Chem. Co. v. Warner-Jenkinson Co.*, 62 F.3d 1512, 1519 (Fed. Cir. 1995), *rev’d* 520 U.S. 17 (1997) (“Intent is not an element of infringement. A patent owner may exclude others from practicing the claimed invention, regardless of whether infringers even know of the patent . . .”) (internal citations omitted). *But see* Roger D. Blair & Thomas F. Cotter, *Strict Liability and Its Alternatives in Patent Law*, 17 BERKELEY TECH. L.J. 799, 800–07 (2002) (framing patent infringement as a “modified strict liability” tort in which actual or constructive notice of the patent may, indeed, be relevant to the extent of the infringer’s liability).

27. *See* 5 DONALD S. CHISUM, *CHISUM ON PATENTS: A TREATISE ON THE LAW OF PATENTABILITY, VALIDITY AND INFRINGEMENT* § 16.02[1] (2014) (explaining that “[a] patent

where mutual blocking patents²⁸ carry a greater risk of creating patent thickets and in those less characterized by overlapping rights.²⁹ The optimality of a twenty-year patent term³⁰ may balance the incentive to innovate with the search cost associated with avoiding infringement differently in industries with relatively short product life, such as software,³¹ compared to industries where product development and regulatory approval cycles can be quite long, such as in the pharmaceutical field.³² Thus, the ideal patent term may vary with the useful life of the patented invention.³³ Significantly, the sufficiency of a

basically grants to the patentee and his assigns the right to *exclude* others from making, using, and selling the invention” but “does not grant the affirmative right to make, use or sell”).

28. The phenomenon of blocking patents arises from the many-to-one relationship that often exists between patents and their associated products or services: where separate patents claim different aspects of the same invention, each patentee may block the other from fully practicing the invention in a commercially meaningful way. See Adam Mossoff, *Exclusion and Exclusive Use in Patent Law*, 22 HARV. J.L. & TECH. 321, 330–35 (2009) (providing a discussion of the conceptual role of blocking patents in the view of patents as exclusionary rights).

29. See Cahoy, *supra* note 18, at 616–18 (noting that incentives for property holders in the technology industry create overlapping interests); see also Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, in 1 INNOVATION POLICY AND THE ECONOMY 119, 120 (Adam B. Jaffe et al eds., 2001) (describing patent thickets as a “dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology” and explaining that they are an extreme case of the commercial impasse that can arise from mutual blocking patents). Affected industries include biotechnology, where a fragmentation of diffusely held patent rights on intellectual resources, such as genetic information, may create an anticommons in which product development would impose high transaction costs to bundle together all the relevant rights to avoid hold-up. See Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 698 (1998) (hypothesizing that today’s upstream biomedical research is increasingly likely to become more privatized and supported by private funding, possibly resulting in more frequent overlapping patent claims).

30. See 35 U.S.C. § 154 (2012) (generally providing, subject to adjustments for undue examination delays, that the term of a patent shall expire twenty years from the filing date of the earliest application to which the patent claims priority).

31. FED. TRADE COMM’N, THE EVOLVING IP MARKETPLACE: ALIGNING PATENT NOTICE AND REMEDIES WITH COMPETITION 109 (2011) [hereinafter 2011 FTC REPORT].

32. See *id.* at 91–92.

33. Cahoy, *supra* note 18, at 618–19 (addressing the pros and cons of a flexible patent law system). The economic impacts on innovation of fixed patent terms—and the econometric estimation of optimal variable patent terms—have received considerable attention in economic literature. See, e.g., Eric Budish et al., *Do Fixed Patent Terms Distort Innovation? Evidence from Cancer Clinical Trials*, NBER PROGRAM ON PRODUCTIVITY, INNOVATION, & ENTREPRENEURSHIP 1–2, 5 (2013) (focusing on distortion of research and development under fixed patent terms for cancer treatments); Louis Kaplow, *The Patent-Antitrust Intersection: A Reappraisal*, 97 HARV. L. REV. 1815, 1821–27 (1984) (suggesting a framework for approaching the patent-antitrust conflict, defining the optimum patent life from an economic viewpoint); F.M. Scherer, *Nordhaus’ Theory of Optimal Patent Life: A Geometric Reinterpretation*, 62 AM. ECON. REV. 422, 423–24 (1972) (extrapolating upon a recent empirical analysis calculating the optimum duration of patent protection); Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. ECON. PERSP. 29, 37–38 (1991) (concluding that

disclosure—in providing public notice of a patent’s boundaries or in teaching the invention to the ordinarily skilled artisan—may vary based on whether, for example, the pertinent art employs a standardized vocabulary,³⁴ whether the art addresses predictable versus unpredictable natural phenomena,³⁵ or even fundamentally whether, in a given art, the appropriability of inventive rewards from trade secrecy “outweighs the benefits of patent exclusivity” in the invention.³⁶

In view of these public policy consequences, a growing body of empirical scholarship has characterized the differing roles that patents play across technologies and industries. The seminal study of this kind is that of Professors Wesley Cohen, Richard Nelson, and John Walsh, finding that firms employ a variety of protections for the profits associated with their inventions beyond

social value is not linked to research costs, and as a result, the information used to calculate optimum patent length is exclusively available to patent examiners and the courts).

34. See, e.g., JAMES BESSEN & MICHAEL J. MEURER, PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATORS AT RISK 153, 201 (2008) (attributing the increased value of patents in the field of chemical structures and compositions in part to concrete and standardized boundaries put on patents in those fields, and vice-versa in the case of software and semiconductors). One prominent proposed policy response has been to require patent applicants to more clearly delineate *ex ante* the bounds of their claims by, for example, defining specialized terms and distinguishing between limitative and illustrative embodiments. See Peter S. Menell, *Promoting Patent Claim Clarity* 1–2 (Univ. of Berkeley, Research Paper No. 2171287, 2012), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2171287.

35. Construing *In re Wands*, 858 F.2d 731 (Fed. Cir. 1988), the USPTO expressly gauged, among several factors, the “predictability . . . of the art” when evaluating whether the applicant has sufficiently enabled her invention for purposes of 35 U.S.C. § 112. See MANUAL OF PATENT EXAMINING PROCEDURE ch. 2164.01(a) (9th ed. 2014). The relevance of scientific unpredictability on technology-specific patentability outcomes came to a head in *Ariad Pharmaceuticals, Inc. v. Eli Lilly & Co.*, 598 F.3d 1336, 1351 (Fed. Cir. 2010), in which the court noted two distinct, co-equal purposes of 35 U.S.C. § 112: to establish that (1) the inventor possessed the claimed invention, and (2) that the inventor adequately taught the ordinarily skilled artisan how to practice the claimed invention. However, commentators have variously emphasized and minimized the relevance of the unpredictable arts doctrine following *Ariad*. Compare, e.g., Joseph Jakas, *Encouraging Further Innovation: Ariad v. Eli Lilly and the Written Description Requirement*, 42 SETON HALL L. REV. 1287, 1292 (“For a complex and ever-changing field like biotechnology, the written description requirement provides a useful and straightforward tool for courts in determining what invention an inventor actually possessed at the time he filed his claim.”), with Greg R. Vetter, *Patent Law’s Unpredictability Doctrine and the Software Arts*, 76 MO. L. REV. 763, 796 (“If undue experimentation is understood . . . as . . . learning effort . . . based on lack of predictability in . . . technology, this purpose does not apply in written description[;] . . . the disclosure’s purpose is not to provide information to make and use. [It] is to provide information to allow the artisan to understand what was invented.”).

36. Cahoy, *supra* note 18, at 619–21 (discussing the benefits of both patent transparency and patent secrecy). For a balanced critique of the largely one-sided preference in contemporary legal doctrine and innovation policy for patent-mediated disclosure over trade secrecy, see Anderson, *supra* note 3, at 939–40, 950.

applying for patents, including secrecy, first-mover advantage, and complementary marketing and manufacturing.³⁷

More recently, and with specific focus on high technology, Professors Stuart Graham, Robert Merges, Pam Samuelson, and Ted Sichelman found in the 2008 Berkeley Patent Survey that technology startups often seek and own patents in ways and for reasons that are industry-specific.³⁸ Further, they found that patents, while relatively weak incentives for core innovation activities, confer significant competitive advantages in preventing copying, securing capital, and enhancing market reputation.³⁹ Further building on the Berkeley Patent Survey, Professors Graham and Sichelman have discussed in greater detail the strategic use that entrepreneurs and start-up firms make of patents, such as leverage in cross-licensing negotiations and signaling in capital markets, particularly in the biotechnology and medical device sectors.⁴⁰

At the opposing end are arguments against the essentiality of differences among industries, both as to their usage of the patent system and with respect to the impact of the patent system upon their efficient operation.⁴¹ Repudiating calls for a “post-unitary patent system,”⁴² for example, Robert Armitage has found an absence of industry-specific differences with respect to the relevant criteria for evaluating the merits of a patent system.⁴³ The need to address so-called industry differences in institutional reform, he argues, instead reflects systemic failings that affect certain technology sectors differently or negatively—not for any reason inherent to an affected sector, but merely due to the nascence of patenting in that sector.⁴⁴

37. Wesley M. Cohen et al., *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)* 5, 24 (Nat’l Bureau of Econ. Research, Working Paper No. 7552, 2000).

38. Stuart J.H. Graham et al., *High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey*, 24 BERKELEY TECH. L.J. 1255, 1283, 1297–99 (2009).

39. *Id.*

40. See Ted M. Sichelman & Stuart J.H. Graham, *Patenting by Entrepreneurs: An Empirical Study*, 17 MICH. TELECOMM. & TECH. L. REV. 111, 179 (2010); Stuart J.H. Graham & Ted M. Sichelman, *Why Do Start-Ups Patent?*, 23 BERKELEY TECH. L.J. 1063, 1095–96 (2008).

41. See, e.g., Robert A. Armitage, *The Myth of Inherent and Inevitable “Industry Differences”*: “Diversity” as Artifact in the Quest For Patent Reforms, 13 MICH. TELECOMM. & TECH. L. REV. 401, 403–06 (2007). The agenda of the conference in which Robert Armitage, Senior Vice President and General Counsel of Eli Lilly and Company, presented these arguments included, in pertinent part, the following discussion topics: How “unitary” is the present patent system as a practical matter?; Through what mechanisms, and how effectively, does the patent adapt to different technologies, industries, markets, or innovation practices?; “At what level and how would a ‘post-unitary’ patent system differentiate among economic characteristics and conditions?” See *id.* at 402 (stating that industry differences for patent purposes is unproven).

42. *Id.* (internal quotation marks omitted).

43. See *id.* at 404–07 (listing benchmarks of systemic success as well as failure benchmarks which, Armitage argues, arise uniformly in intellectual property management strategy, regardless of industry sector).

44. *Id.* at 407–12. But see James Bessen, *Patent Thickets: Strategic Patenting of Complex Technologies* 3 (Research on Innovation & Bos. Univ. Sch. of Law, Working Paper No. 0401,

Lastly, on the basis of this and other empirical evidence have come fully normative arguments that the patent system either should, or should not, be making economic policy determinations with explicit regard for differences among technologies and industries. For example, Professors Stuart Minor Benjamin and Arti Rai have advanced a detailed blueprint for applying administrative law principles to the operation of patent law and doctrine.⁴⁵ Their aim was to invigorate judicial review of administrative patent outcomes, particularly in the context of a post-grant opposition system in the United States Patent and Trademark Office (USPTO), with the goal of improving the quality of patents issued by that agency.⁴⁶ Such procedures have since been enacted into law as part of broad reforms in the Leahy-Smith America Invents Act,⁴⁷ including a transitional post-grant review proceeding specific to certain business method patents.⁴⁸

B. Geography-Specificity in Patenting

If discussion of technology-specificity in patents is a live debate, the role of geography in patenting is no less storied. Beginning with the economic work of Professors Adam Jaffe, Manuel Trajtenberg, and Rebecca Henderson to find the elusive “paper trail by which [knowledge flows] may be measured and tracked,”⁴⁹ the geographic analysis of patent citations has generated considerable insight into the broader question of how spillovers from research and development affect productivity and economic growth, whether in particular industries (such as semiconductors⁵⁰), in particular economic sectors (such as

2003), available at www.ssrn.com/abstract=327760 (arguing that aggressive use of cross-licensing affects industries not evenly, but in proportion to industry maturity).

45. See Stuart Minor Benjamin & Arti K. Rai, *Who's Afraid of the APA? What the Patent System Can Learn from Administrative Law*, 95 GEO. L.J. 269, 335–36 (2007).

46. *Id.* at 270–72.

47. Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (codified throughout sections of 35 U.S.C.).

48. See *id.* at § 18. The language defining what are, and are not, eligible business method patents is starkly industry-specific: “[T]he term ‘covered business method patent’ means a patent that claims a method or corresponding apparatus for performing data processing or other operations used in the practice, administration, or management of a financial product or service, except that the term does not include patents for technological inventions.” *Id.* at § 18(d)(1) (emphasis added).

49. Adam B. Jaffe et al., *Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations*, 108 Q. J. ECON. 577, 578 (1993) (citing PAUL KRUGMAN, GEOGRAPHY AND TRADE 53 (1991)). Professor Jaffe and his co-authors found that patents were significantly more likely to cite other patents from the same country, state, and locality (defined by standard metropolitan statistical areas) than to cite patents not so localized, suggesting that geographic proximity has a strong effect on the magnitude of knowledge spillovers. See *id.* at 595–96 (concluding spillovers are geographically localized).

50. See, e.g., Paul Almeida, *Knowledge Sourcing by Foreign Multinationals: Patent Citation Analysis in the U.S. Semiconductor Industry*, 17 STRATEGIC MGMT. J. 155, 155 (1996) (recognizing the concept of “innovative regions”).

universities⁵¹), or for particular organizational structures (such as parent-subsidiary corporations and multinationals⁵²). The Jaffe-Trajtenberg-Henderson study itself has been subsequently updated with methodological refinements⁵³ and further discussion.⁵⁴ The legal literature, too, has explored the geographic dimension of patenting at all stages of innovation.⁵⁵

Innovative activity itself, for example, tracked patent filings quite well as a proxy for invention across geography and over time through the first half-century of U.S. history and revealed, *inter alia*, a strong correlation between patenting activity and proximity to navigable waterways.⁵⁶ Similarly, early U.S. patent policy showed a preference for greater democratic participation from “relatively ordinary individuals” to such an extent that “the rise in patenting was associated with a democratic broadening of the ranks of patentees to include individuals, occupations, and geographic districts with little previous experience in invention.”⁵⁷

More contemporarily-oriented research has conversely found that, in highly innovative environments, such as Silicon Valley, the fact of geographic localization itself is less a driver of innovation than is access to investment

51. See, e.g., Rebecca Henderson et al., *Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting, 1965–1988*, 80 REV. ECON. & STAT. 119, 119 (1998) (exploring the growth of patents sought by universities).

52. See, e.g., Tony S. Frost, *The Geographic Sources of Foreign Subsidiaries’ Innovations*, 22 STRATEGIC MGMT. J. 101, 102 (2001); Jasjit Singh, *Multinational Firms and Knowledge Diffusion: Evidence Using Patent Citation Data 3* (INSEAD, Working Paper No. 2004/75/SM, 2004), available at www.insead.edu/facultyresearch/research/doc.cfm?did=1428.

53. Peter Thompson & Melanie Fox-Kean, *Patent Citations and the Geography of Knowledge Spillovers: A Reassessment: Reply*, 95 AM. ECON. REV. 465, 465 (2005) (summarizing a mode of reassessment).

54. See Rebecca Henderson et al., *Patent Citations and the Geography of Knowledge Spillovers: A Reassessment: Comment*, 95 AM. ECON. REV. 461, 461 (2005) (addressing criticism of the authors’ original study); Thompson & Fox-Kean, *supra* note 53, at 465.

55. See Peter Lee, *Transcending the Tacit Dimension: Patents, Relationships, and Organizational Integration in Technology Transfer*, 100 CALIF. L. REV. 1503, 1536–37 (2012) (providing a discussion of spillover in legal literature).

56. Kenneth L. Sokoloff, *Inventive Activity in Early Industrial America: Evidence from Patent Records, 1790–1846*, 48 J. ECON. HIST. 813, 813, 817 (1988). Professor Sokoloff expressly draws from more general explorations into the economic history of U.S. industrialization. See, e.g., BROOKE HINDLE, *EMULATION AND INVENTION* 25 (1981) (citing the steamboat as an early example of U.S. patents); BROOKE HINDLE & STEVEN LUBAR, *ENGINES OF CHANGE: THE AMERICAN INDUSTRIAL REVOLUTION, 1790–1860* 78 (1986) (discussing the initial American patent system). More importantly, however, he also draws methodologically from econometric analysis into the level and direction of early inventive activity, particularly as to the systematic use of patent data. See Jacob Schmookler, *The Level of Inventive Activity*, 36 REV. ECON. & STAT. 183, 183–84 (1954) (noting the benefits of reviewing patent data); see also DAVID S. LANDES, *THE UNBOUND PROMETHEUS: TECHNOLOGICAL CHANGE AND INDUSTRIAL DEVELOPMENT IN WESTERN EUROPE FROM 1750 TO THE PRESENT* 201 (1969) (citing factors that led to industrial expansion).

57. B. ZORINA KHAN, *THE DEMOCRATIZATION OF INVENTION: PATENTS AND COPYRIGHTS IN AMERICAN ECONOMIC DEVELOPMENT, 1790–1920* 9 (2005).

capital.⁵⁸ Still, in innovation ecosystems characterized by localized knowledge spillovers,⁵⁹ such as the electric vehicle industry, the impacts of industrial agglomeration on R&D investments⁶⁰ and employment⁶¹ suggest that that industry will, indeed, cluster geographically.⁶²

Once granted, patents also receive attention with respect to their transaction across geographies.⁶³ The traditional conception of university-to-industry technology transfer as a market of discrete exchanges, for example, has given way to a model of direct personal relationships with academic inventors—relationships that are better suited to conveying the necessary, but tacit and uncodified, know-how that is associated with the successful exploitation of patents.⁶⁴ Notably, where “technologies are discrete commodities, transaction costs are low, and technical disclosure is adequate, patent licensing should not correlate with geographic distance. However, contrary to expectation, universities do exhibit a notable tendency to license to firms near them.”⁶⁵ Beyond technology transfer, direct monetization of patents through licensing in the shadow of litigation also has geographic consequences, particularly as to taxable patent revenue.⁶⁶

There is also a rich literature on the geography of patent disputes, albeit derived largely from analyses of forum shopping and its consequences in patent

58. Tom Nicholas, *What Drives Innovation?*, 77 ANTITRUST L.J. 787, 806–07 (2011) (discussing venture capital and private equity). The supervening importance of venture capital is also well-characterized empirically. See, e.g., Samuel Kortum & Josh Lerner, *Assessing the Contribution of Venture Capital to Innovation*, 31 RAND J. ECON. 674, 689–90 (2000).

59. See generally Jaffe et al., *supra* note 49, at 26–27 (discussing evidence that such spillovers are geographically localized, but that these locations fade over time).

60. See, e.g., Edward L. Glaeser et al., *Growth in Cities*, 100 J. POL. ECON. 1126, 1130–32 (1992) (explaining that geographic clustering among firms, either in the same industry or across industries, leads to a positive externality of knowledge spillovers, and that this effect is particularly significant in large cities).

61. See, e.g., Stefano Breschi & Francesco Lissoni, *Localized Knowledge Spillovers Versus Innovative Milieux: Knowledge “Tacitness” Reconsidered*, 80 PAPERS IN REGIONAL SCI. 255, 261–62 (2001) (discussing the ways in which knowledge exchange depends on characteristics of the particular technology labor market and on the employment structures of locally clustered firms).

62. Nicholas, *supra* note 58, at 806.

63. See *infra* note 64 and accompanying text.

64. Lee, *supra* note 55, at 1537. Professor Lee drew from the empirical literature of knowledge flows with a focus on particular clusters, such as Silicon Valley and the Boston Route 128 Corridor. See *id.* at 1536 n.215, 1537 (citing 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, 575 (1999)); see also Juan Alcácer & Wilbur Chung, *Location Strategies and Knowledge Spillovers*, 53 MGMT. SCI. 760, 760, 765 (2007) (positing that power firms will try to locate themselves near universities); David B. Audretsch & Maryann P. Feldman, *R&D Spillovers and the Geography of Innovation and Production*, 86 AM. ECON. REV. 630, 639 (1996) (finding areas with higher levels of spillover have increased levels of innovation).

65. Lee, *supra* note 55, at 1536.

66. Khurram Naik, *For Sale. Patents. Never Used: Gaps in the Tax Code for Patent Sales*, 11 J. MARSHALL REV. INTELL. PROP. L. 859, 863–64 (2012).

litigation,⁶⁷ which receives additional context from federal litigation of a complexity analogous to that of patents⁶⁸ and litigation generally.⁶⁹ Two notable departures from this literature look past the geography of litigation—even patent litigation—to the underlying geography of litigated patents.

On one side is Judge Moore’s widely cited empirical study examining forum shopping. Judge Moore describes forum shopping as more than an outcome-driven exercise in estimated win rates, but as a nuanced geographic pursuit of judges and juries who are knowledgeable about particular technologies.⁷⁰ She emphasizes that forum shopping has significant consequences for incentives to innovate.⁷¹ A potential remedy, Judge Moore has argued, is patent specialization at the trial court level, without the stringent venue and transfer rules that would too widely disperse patent infringement case filings throughout the federal judiciary to the detriment of judicial efficiency.⁷²

In contrast to Judge Moore’s argument is Professor Jeanne Fromer’s study of patent disputes, which examines the formation, under permissive venue rules, of geographic clusters that are technology-specific with respect to the underlying patents.⁷³ Professor Fromer argues that, rather than dispersing patent infringement case filings too widely, more restrictive venue and transfer rules would instead lead industries to cluster at those particular geographic centers where the natural concentration of those industries was already high.⁷⁴

67. See, e.g., Scott E. Atkinson et al., *The Economics of a Centralized Judiciary: Uniformity, Forum Shopping, and the Federal Circuit*, 52 J.L. & ECON. 411, 412, 440–41 (2009) (presenting econometric comparisons of adjudicative non-uniformity and forum shopping before and after the establishment of the U.S. Court of Appeals for the Federal Circuit (CAFC)); Jay P. Kesan & Gwendolyn G. Ball, *Judicial Experience and the Efficiency and Accuracy of Patent Adjudication: An Empirical Analysis of the Case for a Specialized Patent Trial Court*, 24 HARV. J.L. & TECH. 393, 411–12, 420–22 (2011) (empirically relating the quality of patent adjudication to the degree of judicial patent specialization, highlighting the “rampant forum shopping” sought to be ameliorated by the 1982 establishment of the CAFC); Saurabh Vishnubhakat, *Reconceiving the Patent Rocket Docket: An Empirical Study of Infringement Litigation 1985–2010*, 11 J. MARSHALL REV. INTELL. PROP. L. 58, 60 (2011) (proposing a new statistical framework for identifying and comparing “patent rocket docket” forums that are commonly targets of forum shopping).

68. See, e.g., Jeffrey L. Perloff et al., *Antitrust Settlements and Trial Outcomes*, 78 REV. ECON. & STAT. 401, 401 (1996) (studying antitrust settlements).

69. See, e.g., Kevin M. Clermont & Theodore Eisenberg, *Exorcising the Evils of Forum Shopping*, 80 CORNELL L. REV. 1507, 1508–11 (1995) (discussing the trends of venue shopping and the consequences the practice may have on litigation).

70. Kimberly A. Moore, *Forum Shopping in Patent Cases: Does Geographic Choice Affect Innovation?*, 79 N.C. L. REV. 889, 899, 907, 925 (2001).

71. See *id.* at 927–28.

72. *Id.* at 932, 934, 936. See also Rochelle Cooper Dreyfuss, *In Search of Institutional Identity: The Federal Circuit Comes of Age*, 23 BERKELEY TECH. L.J. 787, 804–05 (2008) (discussing the benefits of judicial patent specialization at the trial court level, as well as of limiting amendments to venue and transfer law).

73. Jeanne C. Fromer, *Patentography*, 85 N.Y.U. L. REV. 1444, 1447–49 (2010).

74. See *id.* at 1447 (providing examples, including “the pharmaceutical industry in New Jersey and the software industry in Silicon Valley and the Boston and Seattle areas”).

C. *The Public Domain Gap*

While strategic acquisition, transaction, and especially litigation of patents have been the subject of sophisticated technology-specific and geography-specific analysis,⁷⁵ the public domain into which these patents ultimately pass is not well characterized along either dimension. This is not to say that the legal literature is silent on the right of the public to freely use the subject matter of expired patents.⁷⁶ Patent case law, too—especially regarding eligible subject matter itself—has long guarded against preempting a public domain of “basic tools of scientific and technological work.”⁷⁷ Tools that may be excludable for previously being known include expired patents and phenomena or products of nature, even if previously unknown.⁷⁸ Still, specific empirical discussion of the contents and implications of the public domain itself is lacking.

II. THE EXPIRED PATENTS DATASET

The expired patents dataset begins to fill this empirical gap by examining patents that have expired for failure to pay statutorily required maintenance fees.⁷⁹

A. *Data and Methodology*

Comprehensive data containing patent maintenance fee and bibliographic information on issued patents has been available since 2010 through an agreement between the USPTO and Google.⁸⁰ As of June 2013, the updates to information are available through an agreement between the USPTO and Reed

75. See, e.g., *id.* at 1493, 1496 (describing a national study of district court patent cases consisting of at least one patent claim).

76. See, e.g., Perry J. Saidman, *Kan TrafFix Kops Katch the Karavan Kopy Kats? Or Beyond Functionality: Design Patents are the Key to Unlocking the Trade Dress/Patent Conundrum*, 82 J. PAT. & TRADEMARK OFF. SOC'Y 839, 843 (2000) (arguing that “there is solid, ample precedent for the public’s right to copy products in the public domain”); see also *TrafFix Devices, Inc. v. Mktg. Displays, Inc.*, 532 U.S. 23, 29–30, 35 (2001) (holding that the patentability of the dual-spring configuration of TrafFix’s sign stand created a presumption of functionality that counseled against trade dress protection, which only extends to distinctive and non-functional aspects of appearance).

77. *Gottschalk v. Benson*, 409 U.S. 63, 67 (1972).

78. See Richard Seth Gipstein, *The Isolation and Purification Exception to the General Unpatentability of Products of Nature*, 4 COLUM. SCI. & TECH. L. REV. 1, 7 (2003). Nor, arguably, must these two sets of exceptions be doctrinally coherent with each other “beyond both being corollaries of the principle of an inviolable public domain.” *Id.*

79. See 35 U.S.C. § 41(b) (2012). All patents that issue from applications that were filed on or after December 12, 1980 are subject to three maintenance fees, payable three and a half years, seven and a half years, and eleven and a half years from the date of issuance and each with a six-month grace period. *Id.* Failure to pay these maintenance fees results in the expiration of the patent at the end of the grace period: four, eight, or twelve years from issuance, respectively. *Id.*

80. See Press Release, U.S. Patent & Trademark Office, USPTO Teams with Google to Provide Bulk Patent & Trademark Data to the Pub. (June 2, 2010), available at www.uspto.gov/news/pr/2010/10_22.jsp.

Technology and Information Services (RTIS).⁸¹ Merging these two data sources⁸² by patent number enabled the construction of a dataset comprising the following original variables:

- patent number;
- patent application filing date;
- patent issuance date;
- patent technology class;
- patent technology subclass;
- inventor name;
- inventor city (for domestic inventors);
- inventor state (for domestic inventors);
- inventor zip code (for domestic inventors, if available);
- country code (for foreign inventors);
- dates of all maintenance events; and
- event codes describing all maintenance events.⁸³

Using the patent technology class, the resulting dataset was matched to the Hall-Jaffe-Trajtenberg aggregate technology category and subcategory system by concordance to the U.S. Patent Classification system.⁸⁴ The dataset additionally comprised patent age at expiration. The concordance uniquely assigns categories and subcategories to 418 U.S. patent classes, leaving an additional ten unassigned U.S. patent classes that were created after the last Hall-Jaffe-Trajtenberg concordance was developed. For these remaining U.S. patent classes, Hall-Jaffe-Trajtenberg categories and subcategories were manually assigned as shown in Table 1.

The resulting dataset was filtered to keep expiration events—events reflecting a failure to pay the maintenance fee—that took place between January 1, 2008

81. *Reed Technology Announces Launch of USPTO Public Data Dissemination Site, Expansion of Reed Tech Patent Advisor Service*, BUS.WIRE, <http://www.businesswire.com/news/home/20130620005234/en/Reed-Technology-Announces-Launch-USPTO-Public-Data#.VKxPgtYRPwI> (last updated June 20, 2013, 11:50 AM).

82. *See USPTO Bulk Downloads: Patent Grant Bibliographic Data*, GOOGLE, www.google.com/googlebooks/uspto-patents-grants-biblio.html (last visited Jan. 6, 2014); *USPTO Bulk Downloads: Patent Maintenance Fees*, GOOGLE, www.google.com/googlebooks/uspto-patents-maintenance-fees.html (last visited Jan. 6, 2014).

83. *See U.S. Patent Grant Maintenance Fee Events File*, GOOGLE 1-11 (Dec. 2009), available at storage.googleapis.com/patents/maint_fee_events/current/MaintFeeEventsFileDocumentation.doc. For documentation explaining the country codes, specifically, *see Country Codes*, USPTO PAT. FULL-TEXT & IMAGE DATABASE, www.uspto.gov/patft/help/helpetry.htm (last updated July 31, 2014).

84. *See generally* Bronwyn H. Hall et al., *The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools 1* (Nat'l Bureau of Econ. Research, Working Paper No. 8498, 2001). *See also The NBER U.S. Patent Citations Data File: Lessons, Insights, and Methodological Tools*, NAT'L BUREAU ECON. RES., <http://www.nber.org/patents/> (last updated May 16, 2012) (providing the category and subcategory definitions, as well as the concordance).

and December 31, 2012. Descriptive statistics were then generated for this final dataset.

B. Discussion

Overall, the mean age of patents that expired during each month in the five-year observation window was stable at 8.18 years (coefficient of variation = 4.4%), coinciding with the second maintenance fee payment.

Segmented by Hall-Jaffe-Trajtenberg technology category, the mean expiration age of patents ranged from 7.5 to 9 years as shown in Figure 1. Among expiring cohorts, “Computers and Communications” patents were consistently the youngest at expiration, followed by “Electrical and Electronic.” Older still at expiration were “Mechanical” and “Other” patents, which generally tracked and intersected one another’s trends. Finally, “Chemical” and “Drugs and Medical” patents were the oldest at expiration.

Notably, beginning around August 2009, the mean age of expiring patents in all categories rose together, peaked around March 2010, and fell together until June 2010. Figure 2 summarizes these trends. At the mean, the estimated months in which each of these expiration cohorts had previously issued are shown in Table 2.

Similarly, starting around June 2011, the mean age of patents in all categories rose together, peaked around January 2012, and fell together until June 2012. Figure 3 summarizes these trends. Table 3 illustrates the estimated months in which each of these expiration cohorts previously issued.

Figure 4 confirms these trends by an alternate visualization, using the mean patent age of each monthly expiration cohort to estimate the mean month in which that cohort of patents had issued. Just as each of the two time periods described in Figures 2 and 3 and Tables 2 and 3 correspond in Figure 1 with a rise and a fall in mean expiration age, so also do these two time periods correspond in Figure 4 with the contractions identified within the otherwise linear time lag between issuance and expiration.

These breaks from the otherwise stable issuance-expiration lag suggest prior bursts of issuance activity roughly eight years prior to each rise in the mean expiration age. Figure 5 confirms this intuition, showing a marked rise in patent issuances during each of the two prior issuance time periods estimated in Tables 2 and 3, respectively.

Segmented geographically by U.S. state, the mean expiration age of patents ranged from 6.5 years to 9.5 years, as shown in Figure 6.⁸⁵ Among expiring cohorts, Idaho and Vermont patents were consistently the youngest, while Iowa and New Hampshire patents were largely the oldest. Interestingly, patents from Oklahoma were, by turns, among the youngest at expiration (January 2010–May

85. This analysis looked at those U.S. states with the highest total numbers of patent expirations during 2008–2012. The top thirty-four such states each claimed at least 1,000 patent expirations as determined by the home state of the first-named inventors of the patented inventions.

2010) and among the oldest at expiration (August 2012–November 2012). Figure 7 revisualizes these trends using the mean patent age of each monthly expiration cohort to estimate the mean month in which that patent cohort issued.

Moreover, unlike technology segmentation, which showed similar time trends with a higher or lower mean patent age at expiration, geographic segmentation appears to show a stable mean patent age of approximately eight years while differing by state in its variation from the mean. Thus, as shown in Figure 8, those U.S. states with higher five-year totals in patent expirations showed markedly lower variation in the number of expired patents per month than did those states with lower five-year totals.

Segmented geographically by foreign country,⁸⁶ the mean expiration age of patents ranged from four years to ten years, as shown in Figure 9. Among expiring cohorts, patents from China, Taiwan, and Hong Kong were consistently the youngest, while patents from no single country were consistently the oldest. Figure 10 revisualizes these trends using the mean patent age of each monthly expiration cohort to estimate the mean month in which that cohort of patents issued.

Again, unlike technology segmentation, which showed similar time trends with a higher or lower mean patent age at expiration but in a manner similar to geographic segmentation by U.S. state, geographic segmentation by foreign country appears to show a stable mean patent age of about eight years while differing by foreign country in the variation from the mean. The three countries identified as consistently having the youngest patents in each monthly expiration cohort, however—China, Taiwan, and Hong Kong—are, by definition, exceptions to this trend, as shown in Figures 7 and 8. Thus, as shown in Figure 11, those foreign countries with higher five-year totals in patent expirations showed markedly lower variation in the number of expired patents per month than did those with lower five-year totals.

Cross-segmentation allows comparison of geographic sectors by technology. Figure 12-1 shows the number of expired patents per Hall-Jaffe-Trajtenberg technology category by U.S. state. Figure 12-2 shows the same as a stacked bar chart. Figure 12-3 shows the percentage share of each state's patent expirations across the six Hall-Jaffe-Trajtenberg technology categories.

Because the U.S. states in Figure 12-1 are shown in descending order of five-year total expirations, patents expiring uniformly across technology would reveal a monotonically decreasing distribution from left to right. However, this is not the case. A disproportionately high number of expirations from Texas, for example, were “Computers and Communications” patents. The same was true of Michigan with respect to “Mechanical” patents, and Massachusetts and Maryland with regard to “Drugs & Medical” patents.

86. This analysis looked only at those foreign countries with the highest total numbers of patent expirations during 2008–2012. The top twenty such states each had attributed to them at least 800 patent expirations as determined by the home country of the first-named inventor.

Figure 12-2 substantiates these trends as percentage shares of patent expirations across Hall-Jaffe-Trajtenberg technology categories for each state. Whereas patents expiring uniformly across technology would reveal roughly equal shares of 16.7% within each Hall-Jaffe-Trajtenberg technology category, “Computers and Communications” patents accounted for 29.9% of expirations from Texas, and “Mechanical” patents accounted for 39.1% of expirations from Michigan. Similarly, “Drugs & Medical” patents accounted for 30.7% of patent expirations in Massachusetts and 33.7% of patent expirations in Maryland.

These findings track conventional wisdom regarding Texas as a hub of computer and communications technology;⁸⁷ Michigan as, historically (and again in recent years), a center of mechanical, particularly automotive, technology;⁸⁸ and Massachusetts and Maryland as centers of biotechnology and pharmaceuticals.⁸⁹

Finally, examining similar bibliographic information on newly granted patents during the same time period allows direct comparison between inventions that are entering the domain of patent protection and inventions that are leaving protection for the public domain, a useful comparison across technologies and of particular importance to geographic spillovers. Figures 14-1 and 14-2 show this comparison across U.S. states ordered decreasingly by expirations and grants, respectively. Figures 14-3 and 14-4 show it across

87. See, e.g., Darian M. Ibrahim, *Financing the Next Silicon Valley*, 87 WASH. U. L. REV. 717, 723 (2010) (discussing the rise of Austin, Texas, as a center of high-technology, patterned in part after centrally planned innovation hubs, such as North Carolina’s Research Triangle Park and in part after organic start-up-driven growth centers like Silicon Valley). Professor Ibrahim credits Austin’s planned growth largely to Teledyne founder George Kozmetsky, the so-called “father of Austin high technology,” and the city’s organic growth to start-up firms, including Dell Computer and venture capital firms like Austin Ventures. *Id.* at 723 & n.18.

88. See, e.g., Jennifer Bradley & Bruce Katz, *The One Building that Explains How Detroit Could Come Back: A Plan to Foster Innovation Amidst Bankruptcy*, NEW REPUBLIC (Aug. 28, 2013), www.newrepublic.com/article/114447/one-building-explains-how-detroit-could-come-back.

89. See generally ROSS DEVOL ET AL., AMERICA’S BIOTECH AND LIFE SCIENCE CLUSTERS 32–33 (2004), available at http://assets1c.milkeninstitute.org/assets/Publication/Research_Report/PDF/biotech_clusters.pdf (citing Boston’s second-place rank for biotech innovations). Specifically regarding Massachusetts, see Jarunee Wonglimpiyarat, *Boston Route 128 Revisited*, 2 INT’L J. INNOVATION & TECH. MGMT. 217, 221–22 (2005) (discussing the transformation during the 1990s and onward of Boston’s Route 128 corridor into a hub of biotechnology innovation and knowledge transfer from a previous focus on mini-computer and microprocessor technology), and Gilson, *supra* note 64, at 588–89 (describing the structural origins of the Route 128 corridor’s ecosystem of university-industry collaboration as a product of post-World War II and Cold War federal investment in the cultivation of a technically skilled workforce and of a so-called “agglomeration economy”). With specific regard to Maryland, see SHELDON KRIMSKY, BIOTECHNICS & SOCIETY: THE RISE OF INDUSTRIAL GENETICS 35–36 (1991) (noting that during the early 1990s, half of biotechnology firms in the United States located themselves at a handful of geographic centers, including Maryland), and Alison Peck, *Leveling the Playing Field in GMO Risk Assessment: Importers, Exporters and the Limits of Science*, 28 B.U. INT’L L.J. 241, 265 (2010) (attributing this early geographic positioning to proximity with major bioscience research universities).

foreign countries, similarly ordered decreasingly by expirations and grants, respectively.

As with the previously discussed cross-segment comparison of geographic sectors by technology, the descending order of patent expirations across U.S. states in Figure 14-1 and across foreign countries in Figure 14-3 suggests that commensurate rates of patent grants would reveal a monotonically decreasing distribution from left to right across the same states and countries. This is not the case, however, as a number of U.S. states accounted for patent grants markedly exceeding their incidence of patent expiration; notably, these include Texas, Massachusetts, and Washington, as demonstrated in Figure 14-1. Foreign countries with similar trends, as illustrated by Figure 14-3, include South Korea, Canada, and China.

Conversely, the descending order of patent grants across U.S. states in Figure 14-2 and across foreign countries in Figure 14-4 suggests that commensurate rates of patent expiration would reveal a monotonically decreasing distribution from left to right across the same states and countries. This, too, is not the case, and a number of U.S. states accounted for patent expirations markedly higher than their incidence of patent grants; these notably include Michigan, Pennsylvania, and Ohio, as shown in Figure 14-2. Foreign countries with similar trends include Taiwan, France, and the U.K., illustrated by Figure 14-4.

The economic significance of these grant-to-expiration comparisons resides in the value of patent grants and expirations as indicators of economic growth and decline,⁹⁰ though the reliability of these indicators remains the subject of active debate.⁹¹ Indeed, as analogous trends across technology categories reveal, the relative scale of patent grants and expirations can be instructive as to the economic forces at work.

As Figure 15 shows, patent expirations during 2008–2012 remained fairly stable at around 1,000 per month, albeit with discernible differences among categories, particularly “Drugs and Medical” as the lowest. By contrast, Figure 16 shows patent grants during the same period diverging sharply across technology categories, particularly “Computers & Communications” patents, which nearly doubled from over 4,000 per month in mid-2008 to approximately 8,000 per month by the end of 2012. Similarly, “Electrical & Electronic” patents rose by half from nearly 3,000 per month in mid-2008 to approximately 4,500 by the end of 2012. Monthly patent grants in the other four categories, meanwhile, started between 1,000 and 2,000 per month in mid-2008 and rose to no more than approximately 2,500 per month by the end of 2012.

90. See JONATHAN ROTHWELL ET AL., *PATENTING PROSPERITY: INVENTION AND ECONOMIC PERFORMANCE IN THE UNITED STATES AND ITS METROPOLITAN AREAS 14–15* (2013), available at www.brookings.edu/~media/research/files/reports/2013/02/patenting%20prosperity%20rothwell/patenting%20prosperity%20rothwell.pdf (providing a detailed, geographically segmented analysis of invention and patenting as a driver of regional economic performance).

91. See ZVI GRILICHES, *R&D AND PRODUCTIVITY: THE ECONOMETRIC EVIDENCE* 321 (1998), available at <http://papers.nber.org/books/gri98-1>.

Thus, even in 2008, the magnitude of grants for “Computers & Communications” and “Electrical & Electronic” patents were already out of reach of these technology categories’ respective rates of expirations by three-to-fourfold, and only rose further while expirations remained stable. Thus, as Figure 17 confirms, the rate of patent expirations per month were a *fraction* of patent grants during the same month, which showed only a modest overall decline.

Nevertheless, the rates of grants for patents in the other four technology categories started in 2008 at a scale much closer to that of these categories’ respective rates of expiration, approximately double at most and lower in some cases. Thus, as Figure 17 further shows, the rate of patent expirations per month, as a fraction of patent grants during the same month, was markedly more volatile in its decline among these slower-granting technology categories.

Yet across technologies, the relative stability of expirations per month suggests that the changing throughput of old inventions lapsing into the public domain as new inventions enter into patent protection may not necessarily be the result of patent owners more keenly maintaining their existing rights. Rather, it may result from a large influx of new rights with recent vintage that have largely not yet reached a potential expiration event. In Figure 16, the structural break toward rising patent grants appears to have begun in January 2010, meaning that the first opportunities for these patents to expire arrived in 2014, or will arrive later.

Whether they do expire, or instead prove valuable enough to maintain, transact, or litigate, will implicate persistent and important systemic questions regarding patent examination quality and the economic efficiency of the patent system.

C. Further Research

To answer these questions in an informed and defensible way, further detailed empirical research is required. Accordingly, the data presented here is particularly amenable to matching with related patent data forthcoming from the USPTO and other sources.

Among these is the examination history of applications that have led to issued patents, currently available on an individual basis from the USPTO’s Patent Application Information Retrieval (PAIR) system.⁹² Thus, matching in bulk the expiration data of patents with earlier prosecution events of particular interest, may, on one hand, reveal significant or predictive relationships between

92. *Patent Application Information Retrieval*, USPTO.GOV, portal.uspto.gov/pair/PublicPair (last visited Jan. 7, 2014). In addition to the Public PAIR system, which provides prosecution history information on pending applications and issued patents, the USPTO also provides the Private PAIR system by which registered filers may access Public PAIR information as well as real-time status information, application documents, and transaction history for their own pending patent applications. *Private PAIR: Quick Start Guide*, USPTO 1–2 (Oct. 2009), www.uspto.gov/patents/process/status/private_pair/PrivPairOverview_Oct09.pdf.

examination events and applicant behavior, and the likelihood of expiration on the other. Examination events of interest may include use by examiners of restriction⁹³ and use by applicants of continuation practice⁹⁴ or administrative appeal following a final rejection.⁹⁵ Relatedly, applicant behavior of interest may include the amendment or cancellation of claims or legal counterargument in response to non-final rejections based on various insufficiencies in patentability, such as anticipation, obviousness, indefiniteness, and non-enablement.⁹⁶

Conversely, the assertion of patents in litigation is also likely correlated with incidences of the expiration and maintenance of patents. As recent empirical research shows, whether litigation arises around particular patents is often a complex product of the intrinsic and after-acquired qualities of the patents at issue,⁹⁷ notwithstanding market actors' subjective appetite for risk in the outcomes of patent litigation.⁹⁸ Notably, Professor Colleen Chien has found that

93. Multiple independent and distinct inventions claimed in a single application may be required to be restricted to one of the inventions, with any remaining inventions becoming the subject of divisional applications. See 35 U.S.C. § 121 (2012) (authorizing restriction and division); 37 C.F.R. §§ 1.141, 1.142 (2012) (regulating the treatment of different inventions in a single national application); MANUAL OF PATENT EXAMINING PROCEDURE ch. 800 (9th ed. 2014) (describing USPTO restriction practice).

94. Applications subject to final rejection by the USPTO may receive continued examination with or without amendment, though no new matter may be introduced into the disclosure of the invention. See 35 U.S.C. § 132(a) (authorizing continued examination following a final rejection); 37 C.F.R. § 1.114 (regulating conditions and limitations on requests for continued examination); MANUAL OF PATENT EXAMINING PROCEDURE ch. 706.07(h) (9th ed. 2014) (describing USPTO continued examination practice).

95. Rather than seeking continued examination after final rejection by the USPTO, an applicant may appeal the examiner's decision to the USPTO Patent Trial and Appeal Board (formerly the Board of Patent Appeals and Interferences). See 35 U.S.C. § 134 (authorizing appeal within the USPTO following a final rejection); 37 C.F.R. § 41.64 (regulating *ex parte* administrative appeals of final rejections); MANUAL OF PATENT EXAMINING PROCEDURE ch. 1200 (9th ed. 2014) (describing USPTO appeals practice).

96. The decision to amend or cancel claims, make legal or factual counter-arguments, or employ a mixed approach in response to an examiner rejection is a question of considerable strategic importance because amendments and arguments employed to reach a finding of patentability create estoppel against construing claims too broadly after issuance. See *Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co.*, 535 U.S. 722, 734–35 (2002).

97. See Alan C. Marco & Saurabh Vishnubhakat, *Certain Patents*, 16 YALE J.L. & TECH. 103, 107–12 (2013) (discussing litigation as a decision point in the innovation cycle and sampling the empirical legal literature regarding the qualities of patents that render them more likely to emerge in litigation).

98. See Damon C. Andrews, *Why Patentees Litigate*, 12 COLUM. SCI. & TECH. L. REV. 219, 248–51 (2011) (proposing that litigation costs and risk diminish the value of patent remedies, such as damages and injunctions, so patentees often plan for settlement before investing too heavily in litigation). See also Jay P. Kesan & Andres A. Gallo, *Why "Bad" Patents Survive in the Market and How Should We Change?—The Private and Social Costs of Patents*, 55 EMORY L.J. 61, 68–69 (2006) (quantitatively comparing the costs and risk of litigation between plaintiffs and defendants and concluding that risk aversion can allow even demonstrably invalid patents to persist in the market).

post-issuance investment in patents—including, in her model, the payment of maintenance fees—is correlated with a higher incidence of litigation,⁹⁹ though the robustness of these findings has invited divergent discussion regarding source data and methodology.¹⁰⁰ Moreover, literature suggests that intrinsic patent qualities generated during examination and characteristic of the patent from issuance, such as the number of claims, the number of backward citations to prior art, and the number of jurisdictions in which patent protection is concurrently sought, tends to correlate with patent value,¹⁰¹ which can also drive litigation.¹⁰² It remains a relatively open proposition, however, that the after-acquired qualities of a patent, such as the number of forward citations to that patent in subsequent patents, the post-issuance investment in the patent, and any securitization of the patent, tend to correlate with value. If these qualities correlate with a patent's value, then the relationship among the after-acquired traits of patents, the determinacy of patent value, and the incidence of patent litigation may be endogenous; this may require further disentanglement of cause from effect. For that analysis, matching patent expiration data with litigation data from sources such as the Lex Machina¹⁰³ or Thomson Derwent LitAlert¹⁰⁴ databases may contribute meaningfully.

Addressing the question of patent ownership may be helpful for a range of research questions pertaining to the uses, potential abuses, and lapses of patents into the public domain. By granting access to existing data, the USPTO provides a searchable online query system through its Assignments on the Web interface.¹⁰⁵ The quality of the underlying assignment and ownership information, however, requires improvement,¹⁰⁶ particularly with respect to patents that may be held by so-called patent-assertion entities.¹⁰⁷

99. Colleen V. Chien, *Predicting Patent Litigation*, 90 TEX. L. REV. 283, 304–06, 316–17, 320–21 (2011).

100. Jay P. Kesan et al., *Paving The Path to Accurately Predicting Legal Outcomes: A Comment on Professor Chien's Predicting Patent Litigation*, 90 TEX. L. REV. SEE ALSO 97, 991–02 (2012).

101. See Dietmar Harhoff, Frederic M. Scherer & Katrin Vopel, *Citations, Family Size, Opposition and the Value of Patent Rights*, 32 RES. POL'Y 1343, 1350–52 (2003).

102. See John R. Allison et al., *Valuable Patents*, 92 GEO. L.J. 435, 439–443 (2004) (arguing that the probability of litigation over a patent is a legitimate proxy for the value of the patent).

103. LEX MACHINA, <https://lexmachina.com> (last visited Jan. 7, 2014).

104. Database: LITALERT, STNEASY, <https://stneasy.cas.org/dbss/help.LITALERT.html> (last visited Jan. 7, 2014).

105. *Assignment Search*, USPTO.GOV, assignments.uspto.gov/assignments/?db=pat (last visited Jan. 7, 2014).

106. See, e.g., 2011 FTC REPORT, *supra* note 31, 129–31 (discussing the importance of ascertaining clear patent ownership to the economically efficient clearance of freedom to operate).

107. *Id.* at 74–81, 90–92. The 2011 FTC Report identifies search costs and clarity in the ownership record—apart from claim boundaries and claim construction issues—as distinct inefficiencies in adequately fulfilling the notice function of the patent system, and finds that the resulting market opacity can aggravate the effects of patent assertion entity activity. *Id.*

To this end, the USPTO has been gathering public commentary on potential mechanisms for improving the recordation of patent assignments since November 2011.¹⁰⁸ In June 2013, the USPTO was tasked with developing a notice of proposed rulemaking to require patent applicants and owners to regularly update ownership information at specified times.¹⁰⁹ As these official efforts create greater transparency and more detailed information regarding patent ownership, matching such information to comprehensive data on patent usage outcomes will be a valuable step for scholarly legal analysis of the patent system.

III. CONCLUSION

The central contribution of this paper, and the anticipated value of this new dataset of expired patents and its preliminary descriptive analysis, is to invite and enable more detailed research into the balance of innovation in the United States. Demands on Congress, the federal courts, and the USPTO to strike increasingly nuanced policy balances and ensure that the patent system does not hamper innovation or create economic inefficiency continue to grow.¹¹⁰ The public commons to which all innovative activity must ultimately flow is an important reference point by which to gauge the successes and failures of policy-relevant research, yet the nature of that commons remains to be better characterized.

108. See Notice of Roundtable on Proposed Requirements for Recordation of Real-Party-in-Interest Information Throughout Application Pendency and Patent Term, 77 Fed. Reg. 70,385, 70,385–89 (Nov. 26, 2012) (to be codified at 37 C.F.R. pt. 3); Request for Comments on Eliciting More Complete Patent Assignment Information, 76 Fed. Reg. 72,372, 72,372–74 (Nov. 23, 2011). See also *Roundtable on Proposed Requirements for Recordation of Real-Party-in-Interest Information*, USPTO.GOV, www.uspto.gov/ip/officechiefecon/roundtable_01-11-2013.jsp (last updated June 10, 2013) (listing the full text of public comments and testimony received through these information collections).

109. This USPTO rulemaking is in accordance with the widely publicized White House Task Force on High-Tech Patent Issues, which issued seven legislative priorities and five executive actions for improving innovation incentives in the U.S. economy. See Press Release, The White House, FACT SHEET: White House Task Force on High-Tech Patent Issues (June 4, 2013), available at www.whitehouse.gov/the-press-office/2013/06/04/fact-sheet-white-house-task-force-high-tech-patent-issues.

110. See *id.* (exemplifying the desire to encourage innovation, and thus, to stimulate the U.S. economy).

TABLES AND FIGURES

Table 1. Manual Concordance of Unassigned U.S. Patent Classes

U.S. Patent Class	Half-Jaffe-Trajtenberg Category and Subcategory
Class 703 (Data Processing: Structural Design, Modeling, Simulation, and Emulation)	Category 2—Subcategory 22 (Computers & Communications—Computer Hardware & Software)
Class 715 (Data Processing: Presentation Processing of Document, Operator Interface Processing, and Screen Saver Display Processing)	Category 2—Subcategory 22 (Computers & Communications—Computer Hardware & Software)
Class 716 (Computer-Aided Design and Analysis of Circuits and Semiconductor Masks)	Category 2—Subcategory 22 (Computers & Communications—Computer Hardware & Software)
Class 717 (Data Processing: Software Development, Installation, and Management)	Category 2—Subcategory 22 (Computers & Communications—Computer Hardware & Software)
Class 718 (Electrical Computers and Digital Processing Systems: Virtual Machine Task or Process Management or Task Management/Control)	Category 2—Subcategory 22 (Computers & Communications—Computer Hardware & Software)
Class 719 (Electrical Computers and Digital Processing Systems: Interprogram Communication or Interprocess Communication (IPC))	Category 2—Subcategory 22 (Computers & Communications—Computer Hardware & Software)
Class 720 (Dynamic Optical Information Storage or Retrieval)	Category 2—Subcategory 24 (Computers & Communications—Information Storage)
Class 725 (Interactive Video Distribution Systems)	Category 4—Subcategory 49 (Electrical and Electronic—Miscellaneous-Elec)
Class 726 (Information Security)	Category 2—Subcategory 22 (Computers & Communications—Computer Hardware & Software)
Class 850 (Scanning-Probe Techniques or Apparatus: Applications of Scanning-Probe Techniques, E.G., Scanning Probe Microscopy (SPM))	Category 1—Subcategory 19 (Chemical—Miscellaneous-Chemical)

Figure 1. Mean Age of Expiring Patents by Technology Category (2008–2012) (six-month moving average)

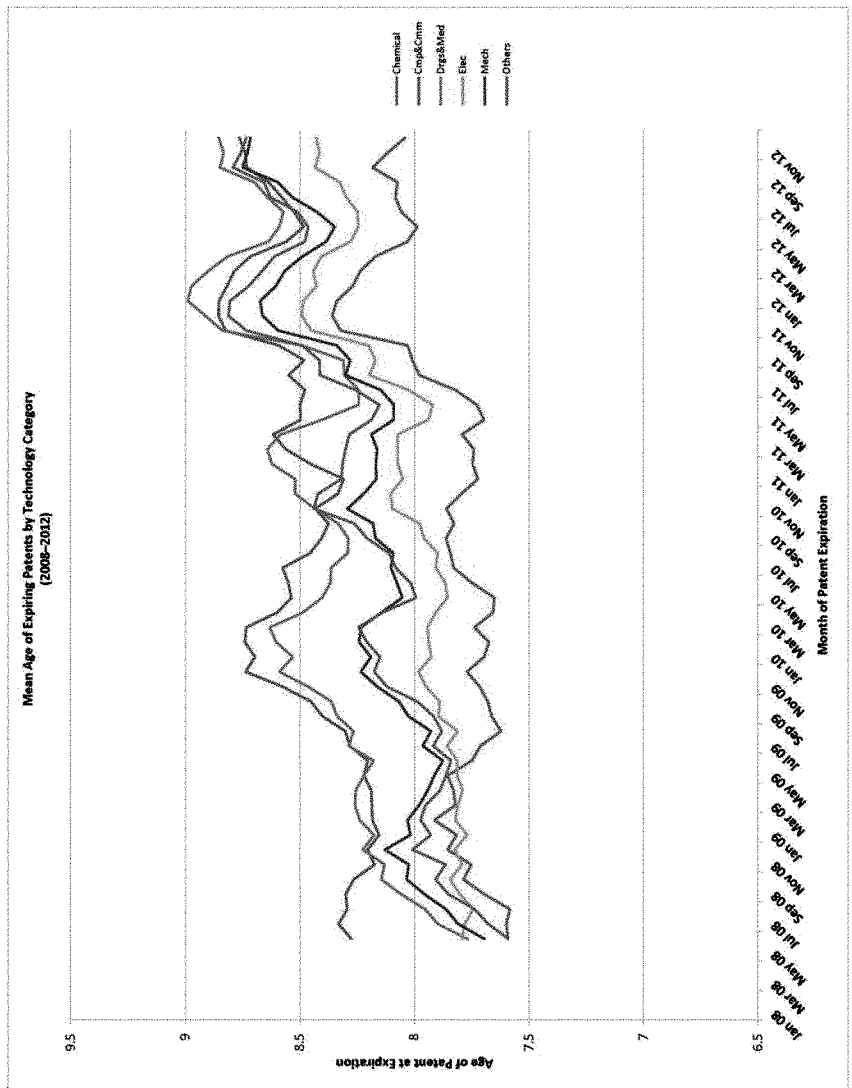


Figure 2. Average Age of Expiring Patents During 2009–2010

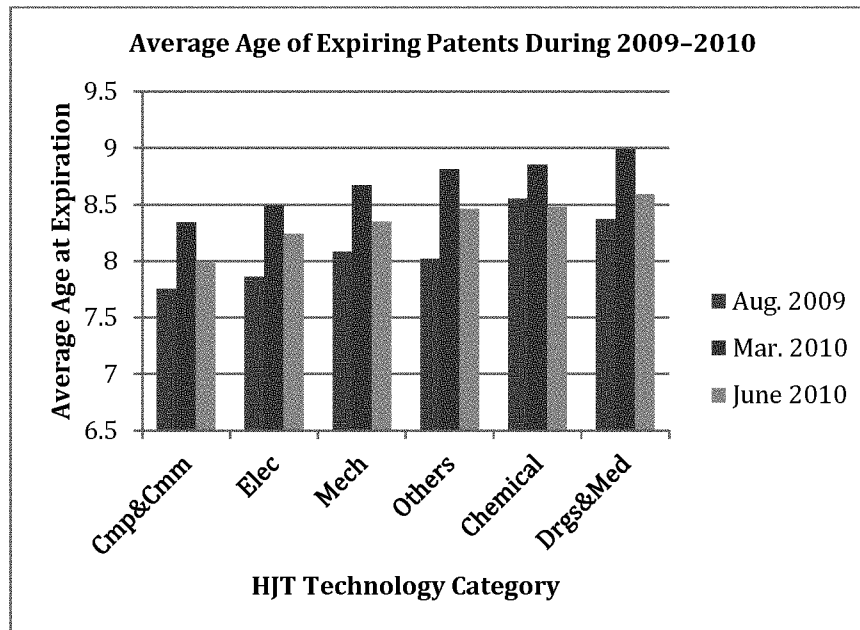


Table 2. Mean Issue Month of Expiring Patents During 2009–2010

Category	Aug. 2009	Mar. 2010	June 2010
Cmp&Cmm	Dec. 01	June 02	Aug. 02
Elec	Oct. 01	Mar. 02	July 02
Mech	Aug. 01	Dec. 01	May 02
Others	Sep. 01	Dec. 01	May 02
Chemical	Apr. 01	June 01	Nov. 01
Drgs&Med	Apr. 01	July 01	Jan. 02

Figure 3. Average Age of Expiring Patents During 2011–2012

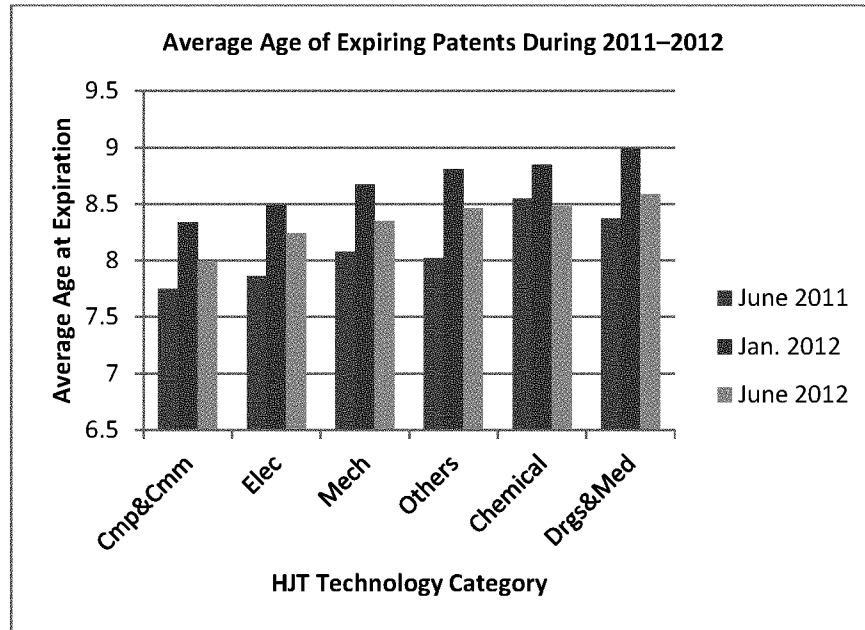


Table 3. Mean Issue Month of Expiring Patents During 2011–2012

Category	June 2011	Jan. 2012	June 2012
Cmp&Cmm	Aug. 03	Aug. 03	June 04
Elec	July 03	July 03	Mar. 04
Mech	May 03	May 03	Jan. 04
Others	May 03	Mar. 03	Dec. 03
Chemical	Nov. 02	Feb. 03	Dec. 03
Drgs&Med	Jan. 03	Jan. 03	Oct. 03

Figure 5. Monthly Issuances of Patents That Eventually Expired During 2008–2012

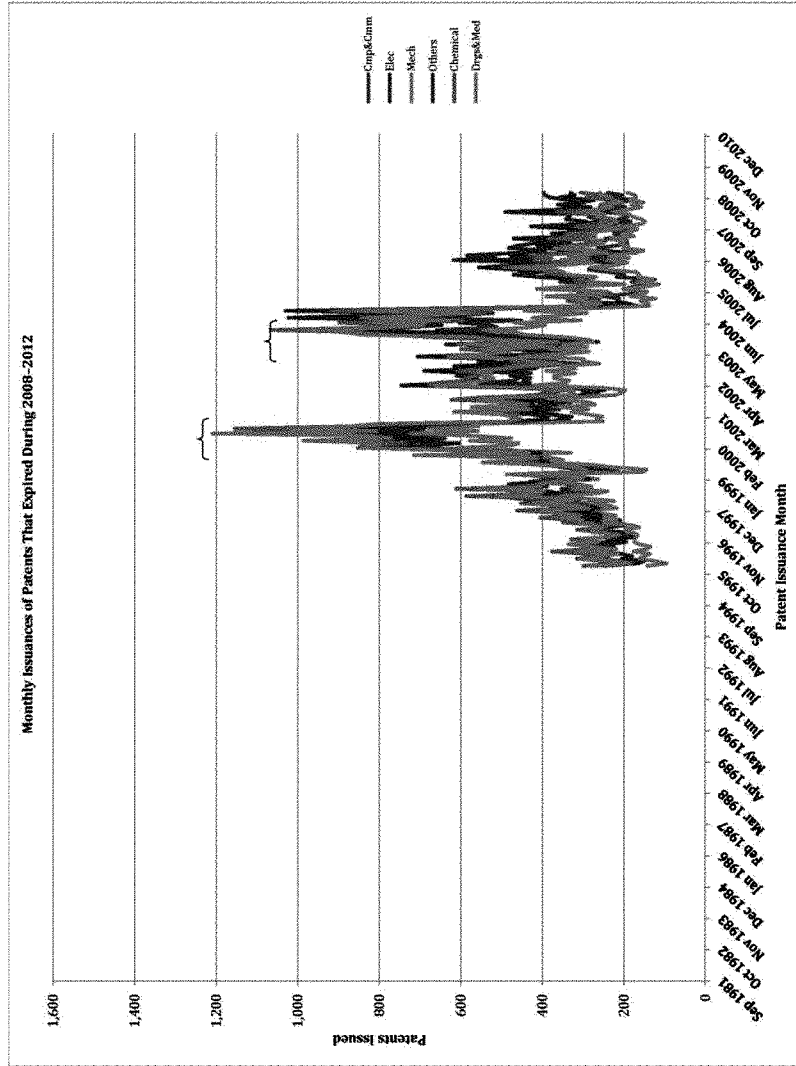


Figure 6. Mean Age of Expiring Patents by U.S. State (2008–2012) (six-month moving average)

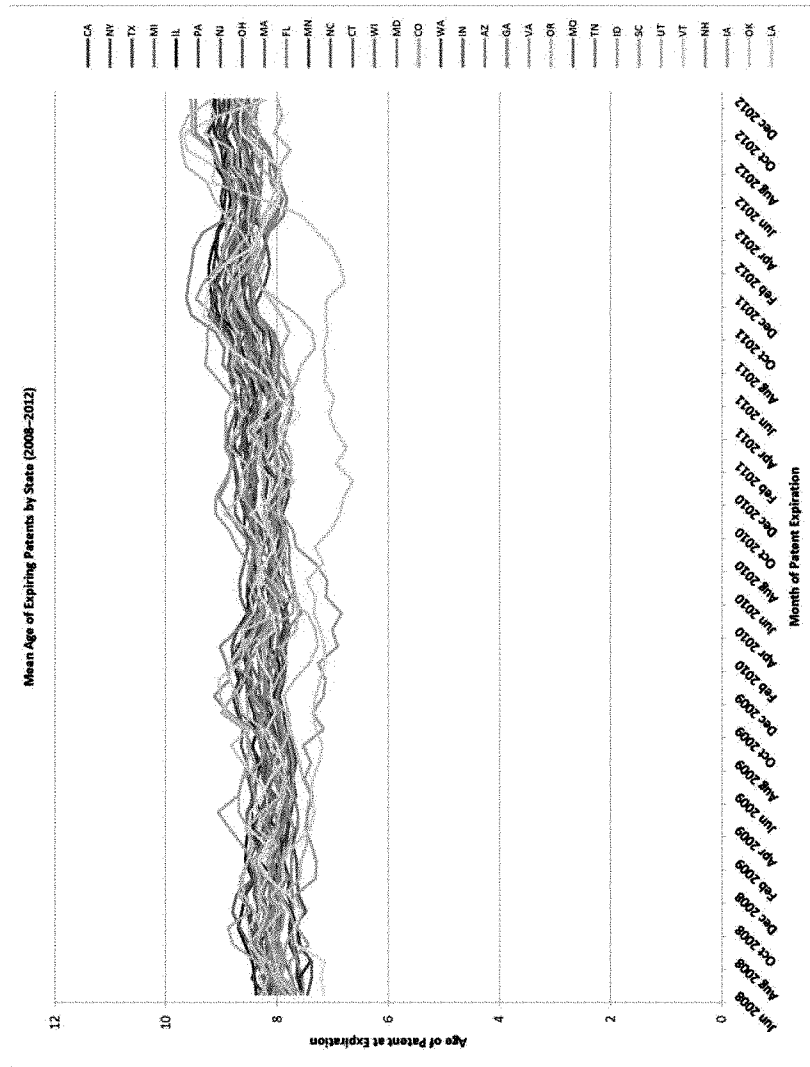


Figure 7. Mean Issue Month of Expiring Patents by U.S. State (2008–2012) (six-month moving average)

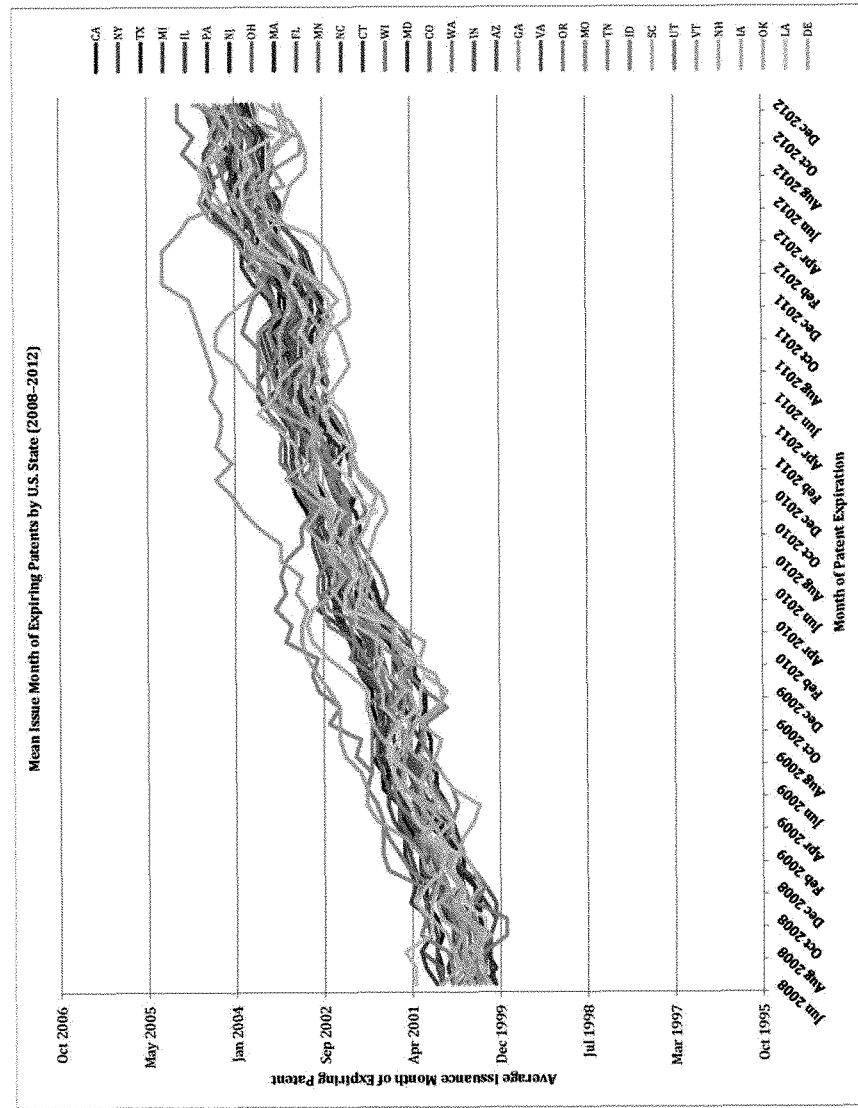


Figure 8. Variation from Mean Patent Age at Expiration for States with the Highest 5-Year Total Patent Expirations

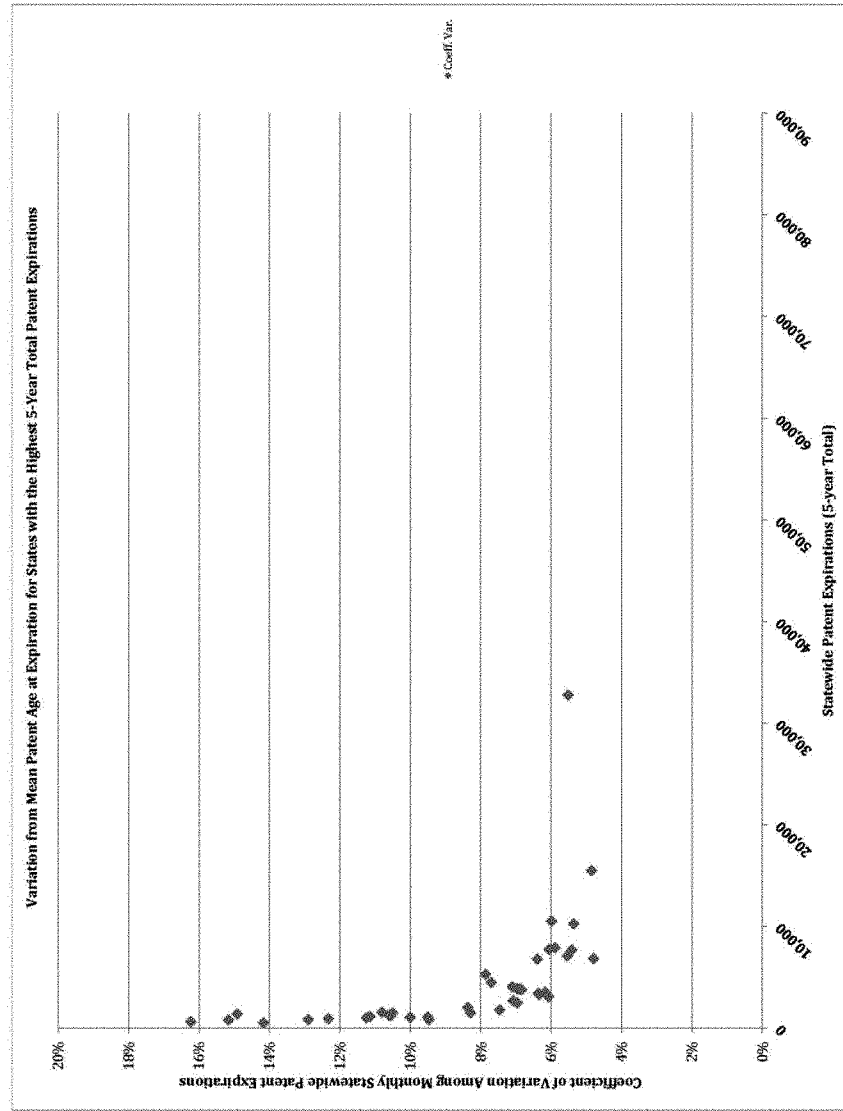


Figure 9. Mean Age of Expiring Patents by Foreign Country (2008–2012)
(six-month moving average)

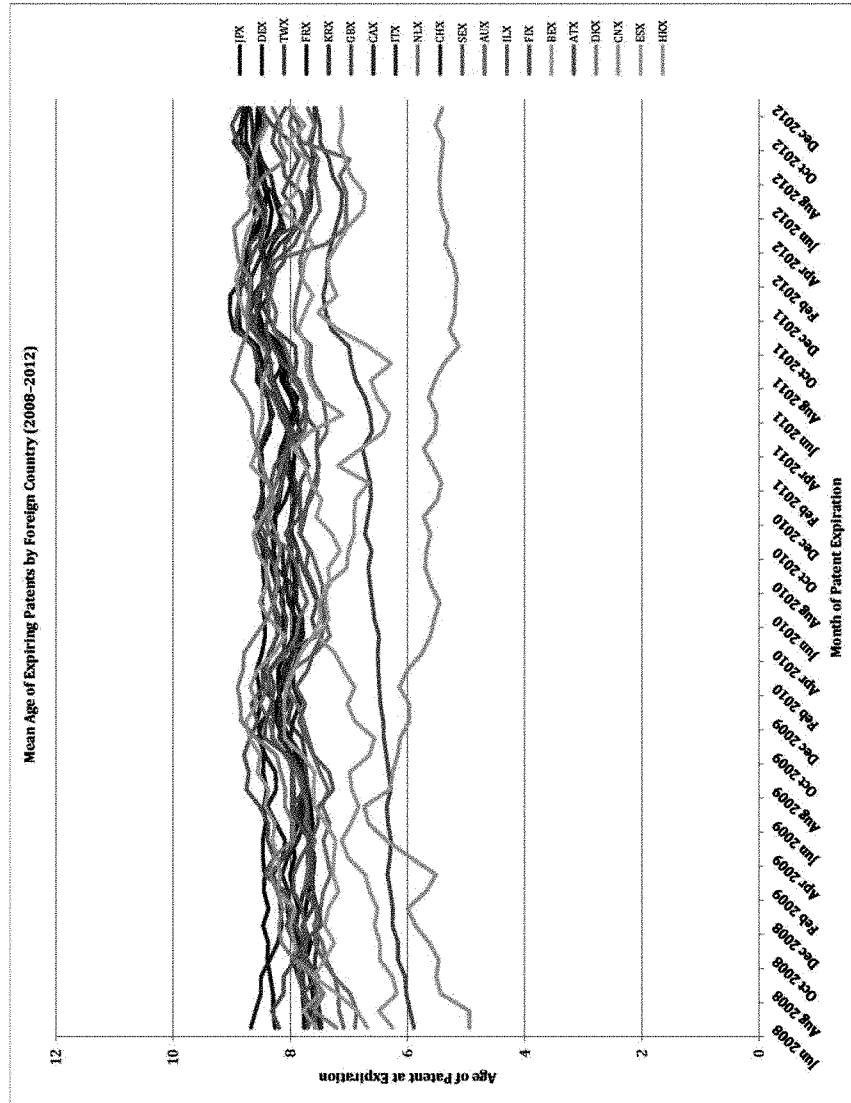


Figure 10. Mean Issue Month of Expiring Patents by Foreign Country (2008–2012) (six-month moving average)

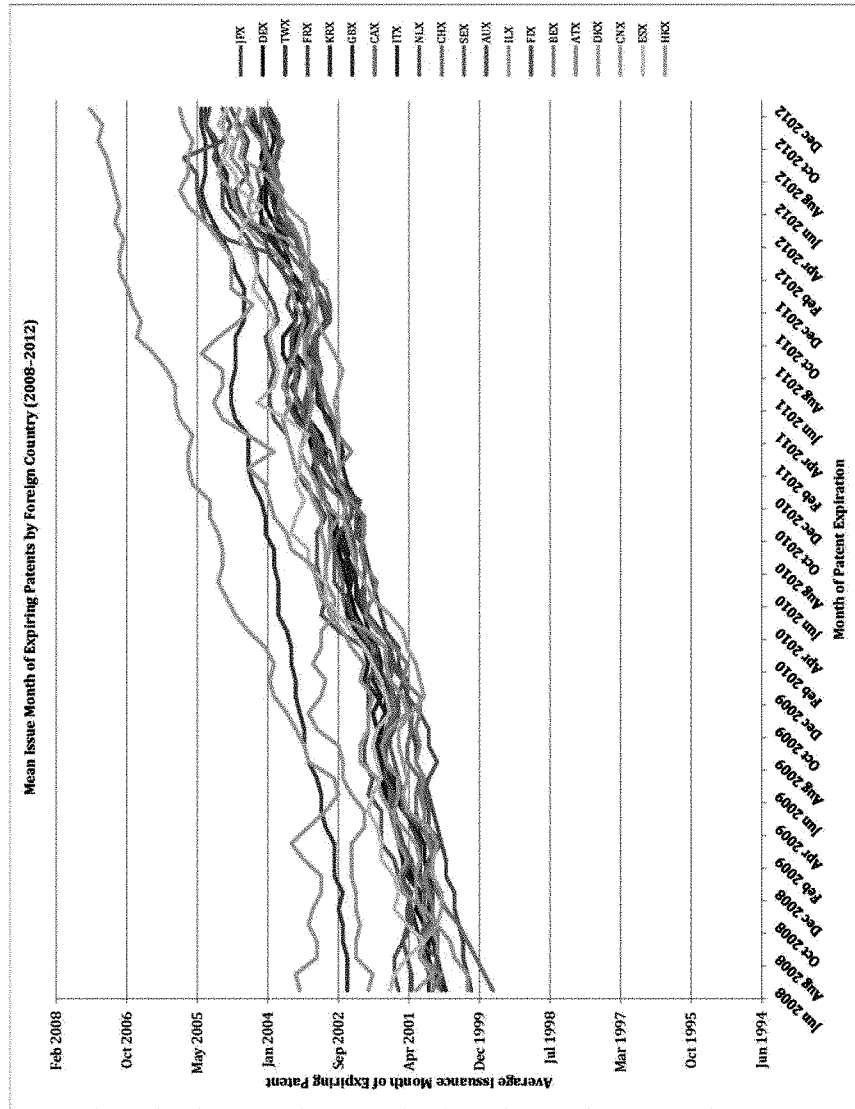


Figure 12-1. Patent Expirations by U.S. State Across Technologies (2008–2012) (six-month moving average)

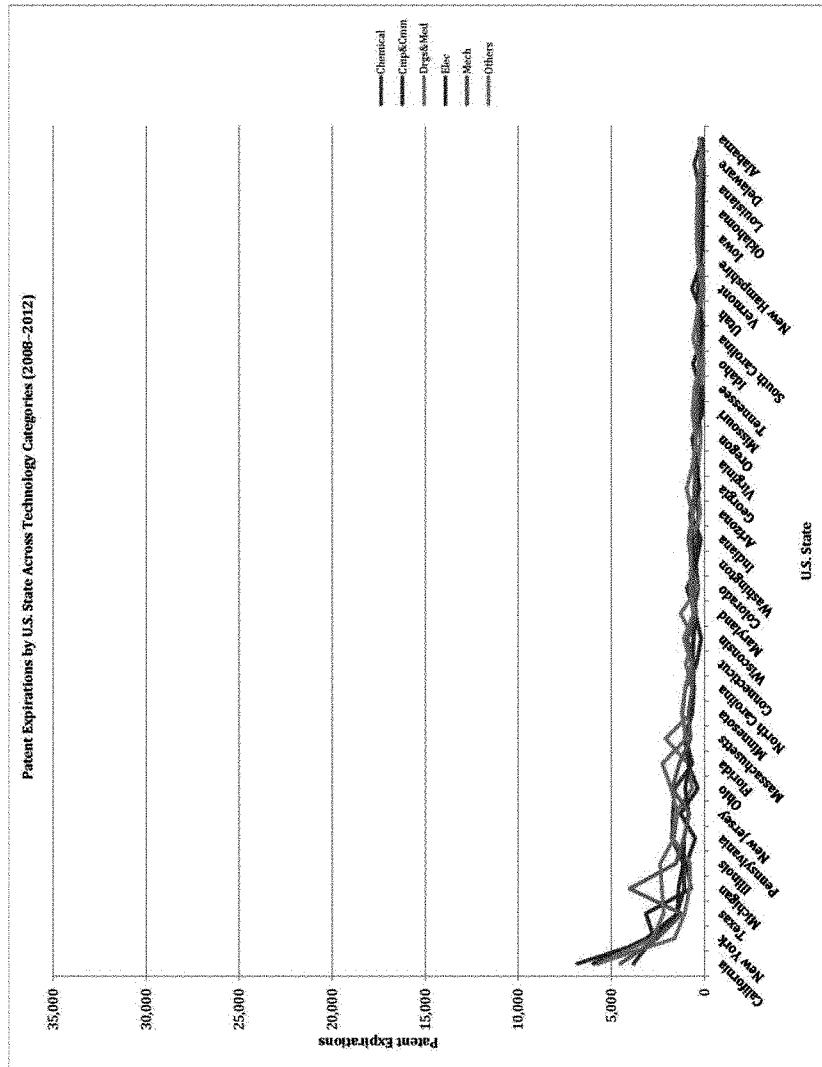


Figure 12-2. Patent Expirations by U.S. State Across Technologies (2008–2012), Percentage per HJT Category

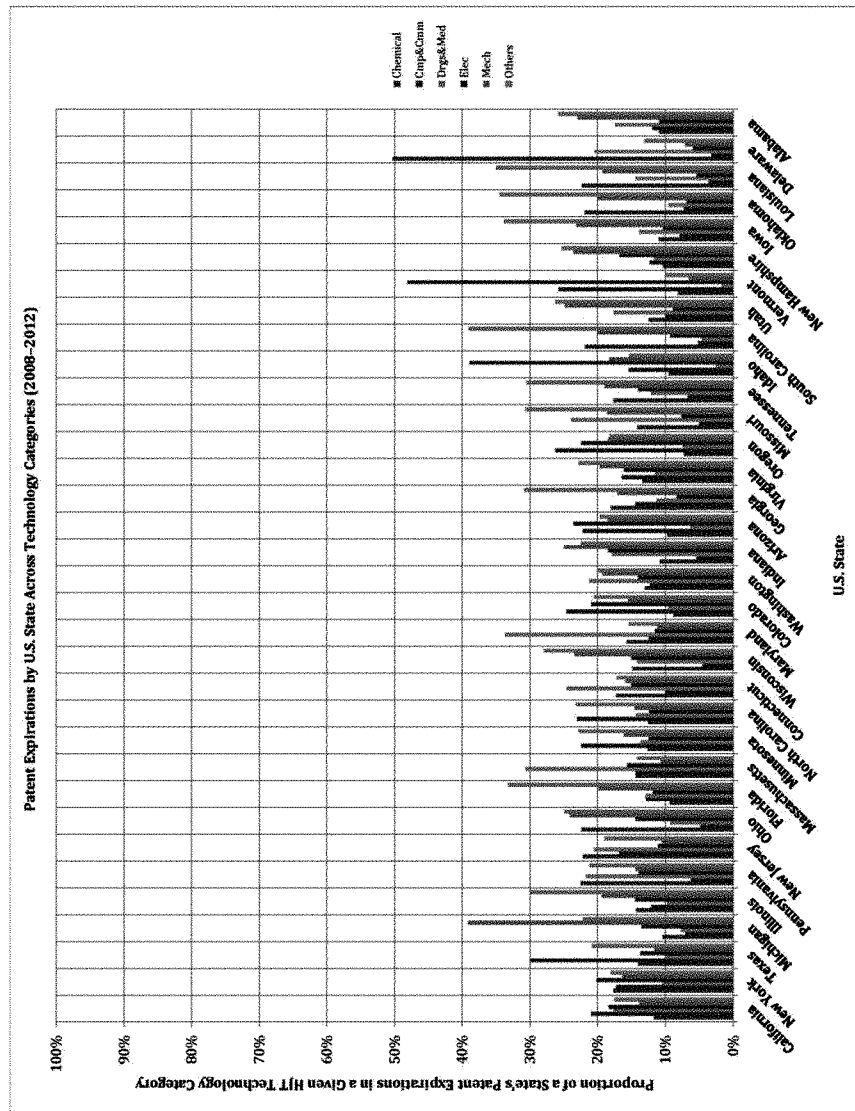


Figure 13. Patent Expirations by Foreign Country Across Technology Categories (2008–2012) (six-month moving average)

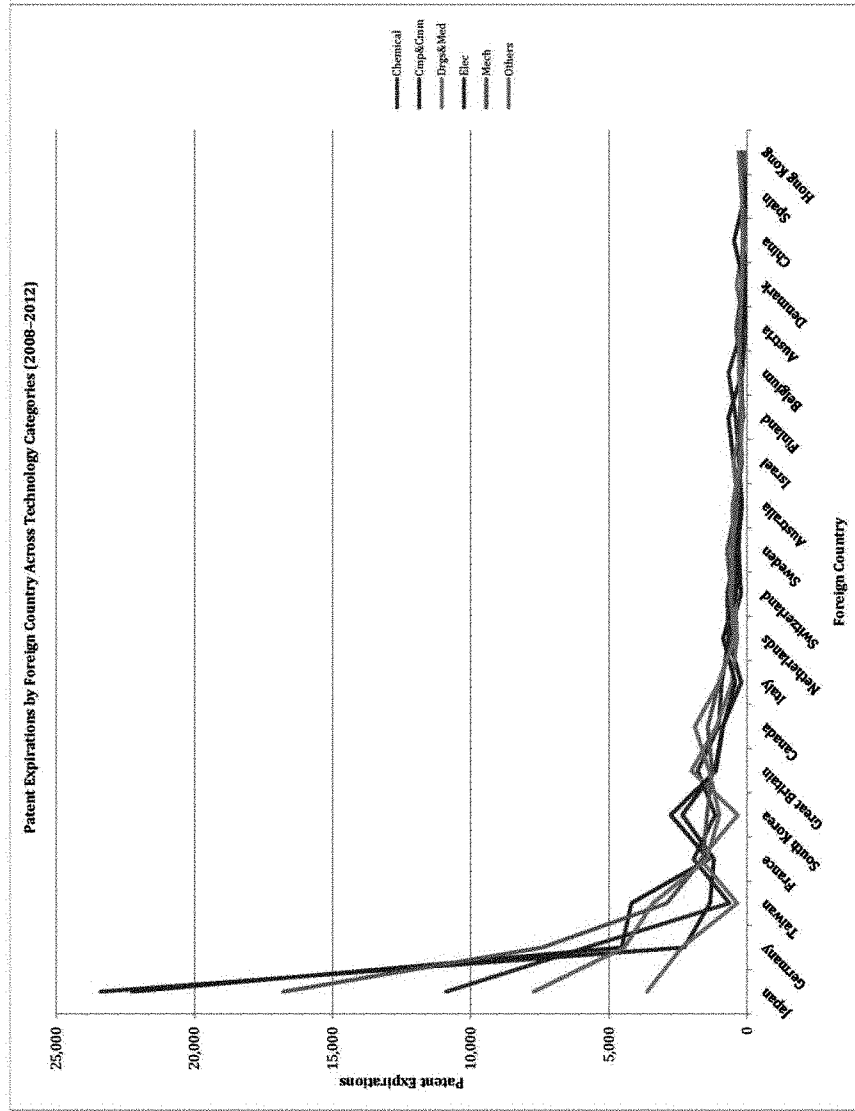


Figure 14-1. Patent Grants and Expirations Across U.S. States (2008–2012): Decreasing by Expirations (six-month moving average)

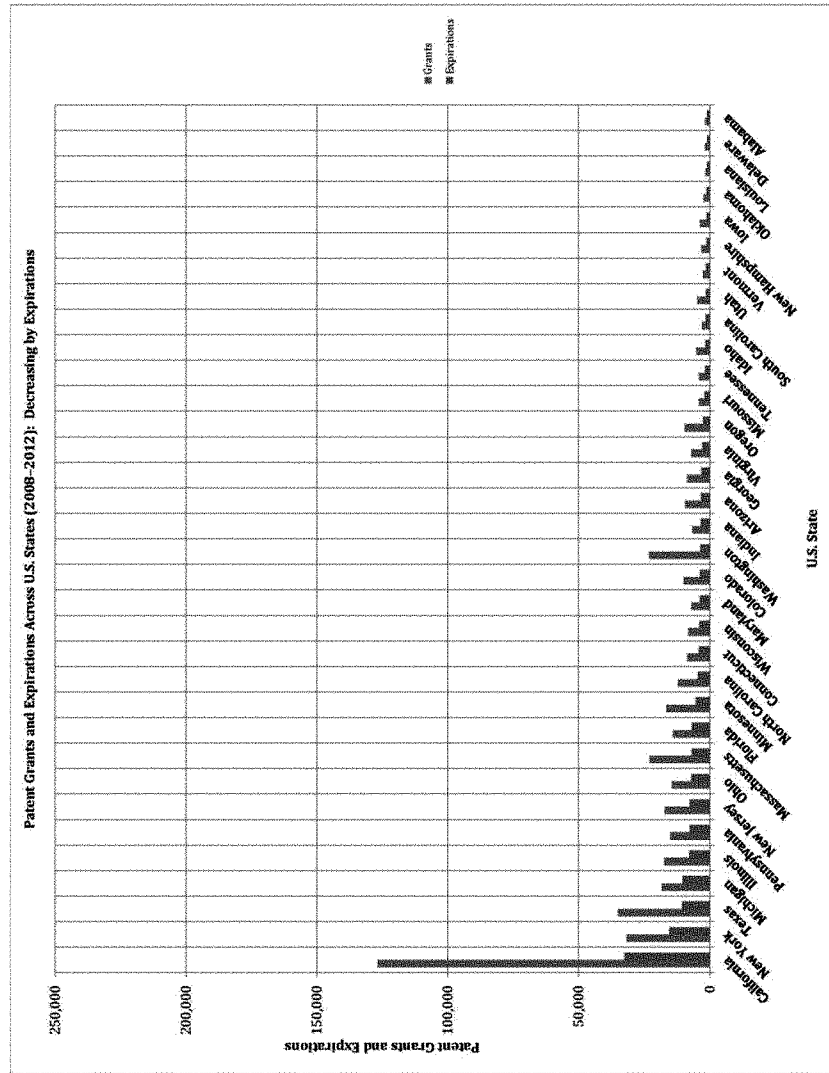


Figure 14-2. Patent Grants and Expirations Across U.S. States (2008–2012): Decreasing by Grants (six-month moving average)

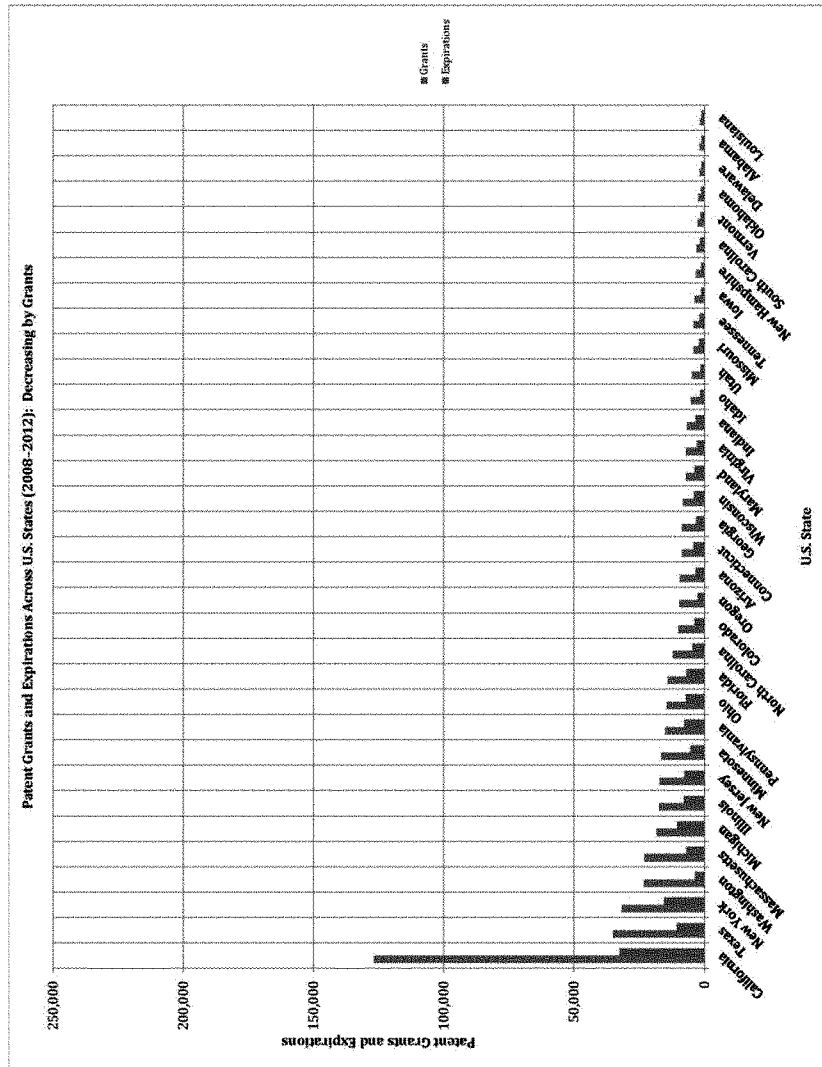


Figure 14-3. Patent Grants and Expirations Across Foreign Countries (2008–2012)

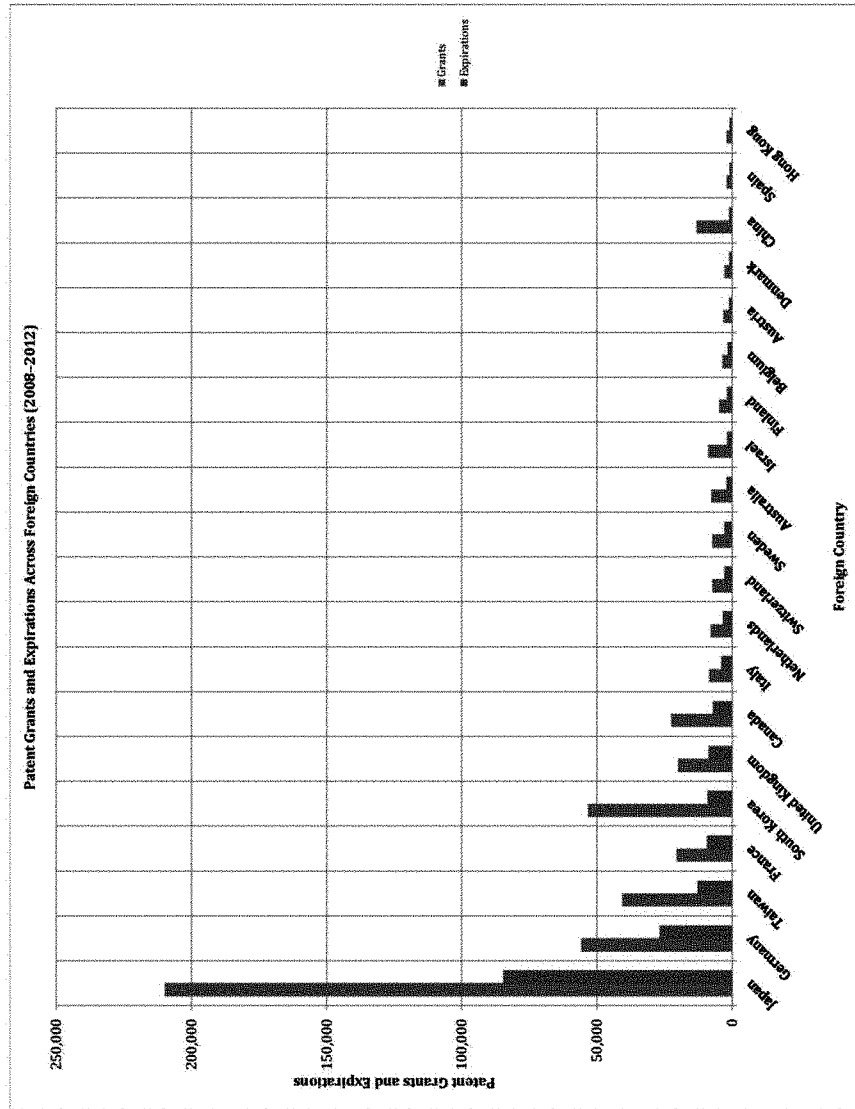


Figure 14-4. Patent Grants and Expirations Across Foreign Countries (2008–2012) (six-month moving average)

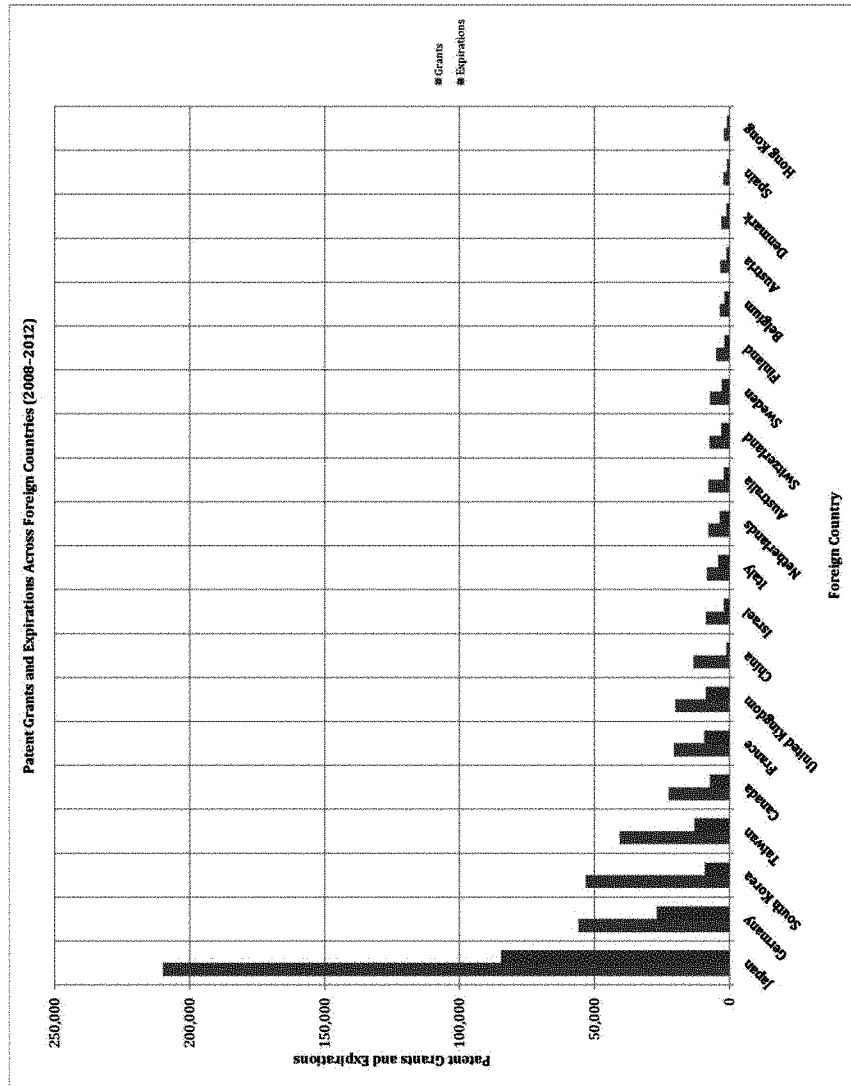


Figure 15. Patent Expirations by Technology Category (2008–2012) (six-month moving average)

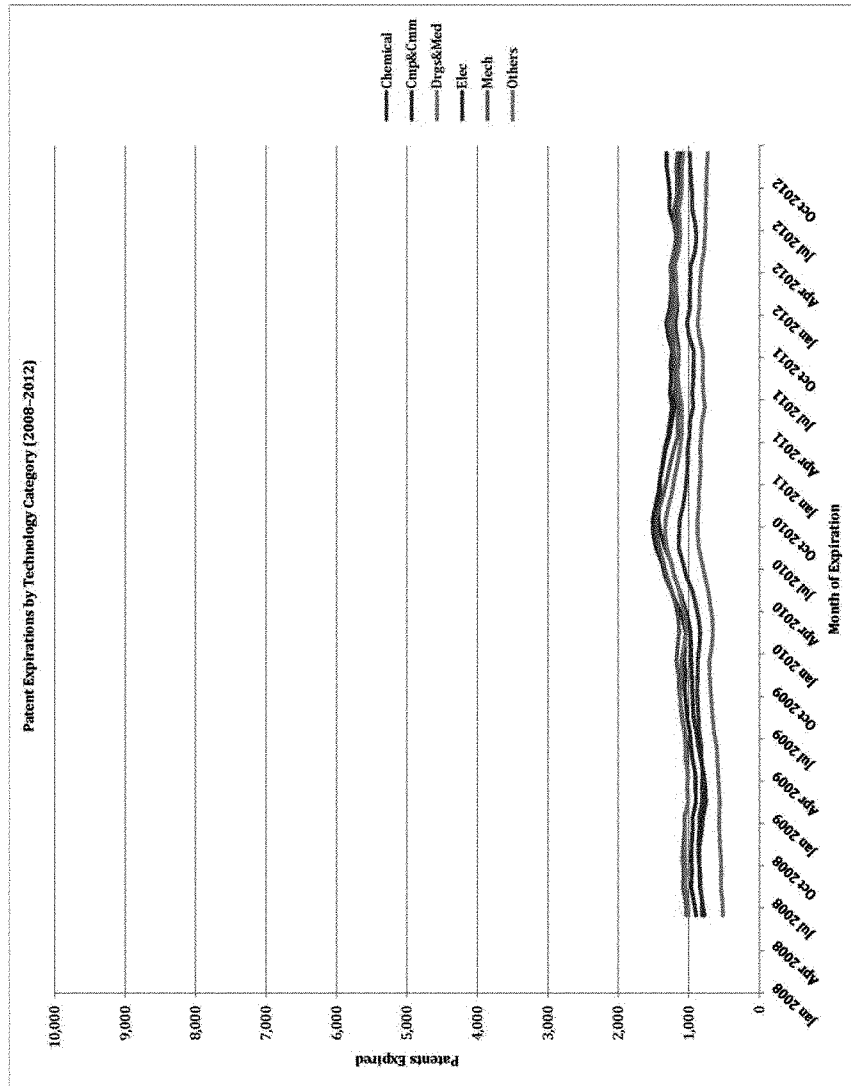


Figure 16. Patent Grants by Technology Category (2008–2012) (six-month moving average)

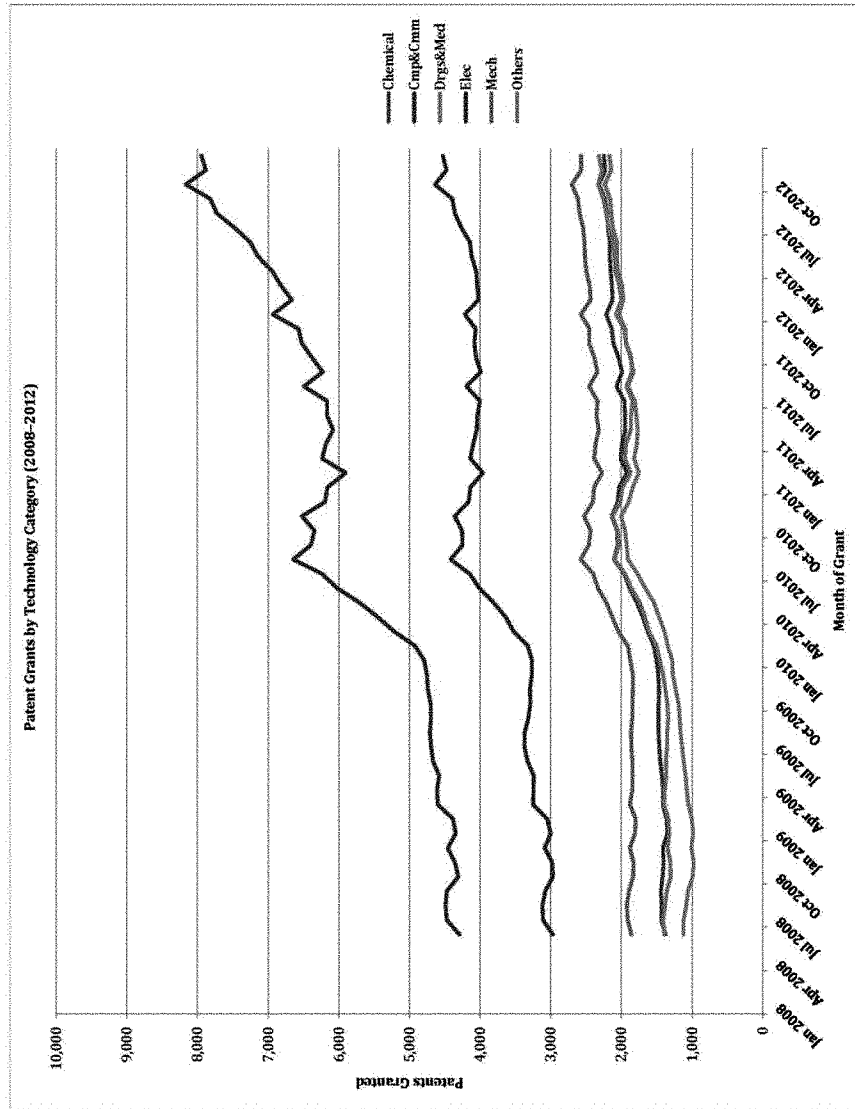


Figure 17. Patent Expirations as a Proportion of Grants by Technology (2008–2012) (six-month moving average)

