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Trolls and Other Patent Inventions
Economic History and the Patent Controversy in the Twenty-First Century

B. Zorina Khan
Bowdoin College
National Bureau of Economic Research

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"Trolls and Other Patent Inventions: Economic History and the Patent Controversy in the Twenty-First Century"

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B. Zorina Khan
Department of Economics
Bowdoin College
Brunswick Maine 04011
and
National Bureau of Economic Research

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ABSTRACT

The most significant changes to the patent and innovation system in the past two centuries have been, or are in the process of being, implemented in the United States today. Critics of patent grants and intellectual property institutions propose alternatives such as unprecedented constraints on the rights of patent owners, and many advocate the award of technological prizes as superior alternatives. Such proposals are motivated by claims that the patent system is in crisis, with new developments that require departures from traditional approaches to property rights and technology policy. The historical record sheds light on the nature and validity of these controversies. In particular, data on patents granted, litigation rates over the past two centuries, and the role of non-practicing entities, indicate that these features of the current market in intellectual property are hardly anomalous. Indeed, they have been inherently associated with disruptive technologies that transformed the United States into the world leader in industrial and economic growth. By contrast, extensive empirical analyses of prize systems in Europe and the United States explain why early enthusiasm about such administered nonmarket-oriented awards had waned by the end of the nineteenth century.

"*It is only by considering the trend of legal development that we can make sure of the direction in which efforts toward improvement can be guided most effectively.*"
– Brander Matthews (1890)[1]

INTRODUCTION

The patent system is the source of widespread dissatisfaction, many scholars and observers call for multi-faceted reforms in its rules and standards, and some even propose the abolition of state-mandated grants of intellectual property. Patents are vilified as unnecessary monopolies that serve to enrich a few corporations and their robber baron executives while harming their competitors and the general public. The popular press is filled with ubiquitous headlines about negative-sum "patent wars" that are waged in boardrooms and courtrooms across the world, culminating in huge litigation and enforcement costs, where the only winners are the lawyers on both sides of the dispute who garner lavish fees regardless of the outcomes. Pervasive copyright piracy of music and other cultural goods leads many to fear the demise of domestic creativity and output. In response to the urging of paid lobbyists, Congress engages in lengthy debates and considers abundant proposals for reforming the patent and copyright system. Prizes and other alternatives to patents are gaining greater favour among the opponents of the existing intellectual property system. In general, these debates and policy proposals are primarily based on rhetoric and self-interest rather than on objective assessments of empirical evidence.

The previous paragraph refers to discussions and debates that were rife in the nineteenth century about patent and copyright systems. Similar claims and counterclaims were prevalent when the British Statute of Monopolies authorized the world's first statutory patent institution in 1624, and have persisted through the centuries with periodic upsurges that replicate the same questions and concerns. In 1950, another period when Congress was paying closer attention to calls for reform, Fritz Machlup and Edith Penrose published an article on "the patent controversy in the nineteenth century," in order to prove that "despite all the changes in the economic scene, our thinking on the subject has hardly changed over the

[1] Brander Matthews, "The Evolution of Copyright," Political Science Quarterly, vol. 5 (1890), p. 594.

century."[2] They described the historical evolution of the patent system and its tendency to generate discontent and debates, culminating in a call to abolish patents in the second half of the nineteenth-century. Their report effectively demonstrated how the same issues and positions were still being rehashed a hundred years later, as if nothing had been learned from history. However, although the authors' stated objective was to provide a more systematic approach to the subject, their article was largely descriptive and not based on empirical evidence.

Facile rejoinders to historical accounts tend to dismiss such experiences as irrelevant to the twenty-first century and the Brave New World of smartphones, silicon chips and one-click patents. Both the new anti-patent abolitionists and their opponents often recycle inaccurate and misinformed historical anecdotes when it serves their purpose, without much regard for the validity of these claims. According to a noted jurist, "a page of history is worth a volume of logic."[3] And, indeed, a systematic historical perspective is necessary to filter out the signal from the noise of the plethora of contradictory claims that are currently prevalent. For, although the technologies are obviously different, much of the underlying economic and legal fundamentals remain unchanged. Legal rules and social reforms may be necessary to fit radical new circumstances, but many of the concerns of today are hardly radical or new, and some have even proved to productive feature of markets in invention since their inception. It should be self-evident that, in a social system based on norms and precedent, "if a thing has been practiced for two hundred years by common consent, it will need a strong case … to affect it."[4]

Who are the new patent dissidents of the twenty-first century? As one might expect, the primary core of the movement consists of lobbies in industry who would benefit from royalty-free usage of patented ideas, but disinterested analysts and academic observers also highlight a range of concerns. Many criticize specific aspects of the administration or consequences of patent rules and standards.[5]

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[2] Fritz Machlup and Edith Penrose, "The Patent Controversy in the Nineteenth Century," Journal of Economic History, vol. 10 (1) 1950: 1–29.
[3] Oliver Wendell Holmes, in New York Trust Co. v. Eisner, 256 U.S. 345, 349 (1921).
[4] Jackman v. Rosenbaum Co., 260 U.S. 22, 31 (1922).
[5] Examples include Bessen, James and Michael J. Meurer: Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk, Princeton, NJ: Princeton University Press, 2008; Dan L. Burk and Mark A. Lemley, The

Some wish to increase access to essential medicines, and others argue that patents do not function effectively in particular contexts such as gene therapies and software.[6] It is interesting to note that the most radical critics consist of a number of eminent theoretical economists with little specialized expertise in intellectual property. They highlight the sort of analysis that is standard in principles of economics classes: patents comprise intellectual monopolies which drive up prices above marginal cost, produce "contrived scarcity," and lead to a social deadweight loss.[7] Gary Becker concludes that it would be advisable to "maintain the patent system on drugs and a few other products that are expensive to innovate and cheap to copy, and eliminate patents on everything else."[8] Joseph Stiglitz, noted for landmark contributions to mathematical theories of asymmetrical information, now advocates prize systems as superior alternatives to patents, "an idea whose time has come."[9] Michele Boldrin and David K. Levine, general equilibrium theorists, are less temperate; they refer to the "evils" of the patent system, and lobby for its complete abolition.[10]

This paper addresses several specific debates about innovation and institutions. The intention is not to provide a comprehensive survey of the literature, but rather to present research findings that may shed light on a number of these issues. The empirical evidence is based on the analysis of large original

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Patent Crisis and How the Courts can Solve it, Chicago: Chicago University Press, 2009; Adam B. Jaffe and Josh Lerner, Innovation and its Discontents: How Our Broken Patent System is Endangering Innovation, Princeton University Press, 2004. Judge Posner has also noted his dissatisfaction with the patent system, in http://www.theatlantic.com/business/archive/2012/07/why-there-are-too-many-patents-in-america/259725/ .

[6] The notion of the public harm of monopolies is prevalent in both academic readings and more populist publications as Harriet A. Washington, Deadly Monopolies: The Shocking Corporate Takeover of Life Itself--And the Consequences for Your Health and Our Medical Future, Random House (2011).

[7] A deadweight loss is a net loss in social welfare that arises from the higher prices and lower output conventionally associated with static analyses of theoretical economic models of imperfect competition.

[8] See http://www.becker-posner-blog.com/2012/09/reforming-the-patent-system-toward-a-minimalist-system-becker.html, accessed Aug 15, 2013.

[9] "The alternative of awarding prizes would be more efficient and more equitable. It would provide strong incentives for research but without the inefficiencies associated with monopolisation. This is not a new idea – in the UK for instance, the Royal Society of arts has long advocated the use of prizes. But it is, perhaps, an idea whose time has come" (Joseph Stiglitz, "Give prizes not patents," New Scientist, 16 September 2006, p. 21.)

[10] "A closer look at the historical and international evidence suggests that while weak patent systems may mildly increase innovation with limited side-effects, strong patent systems retard innovation with many negative side-effects. …Hence the best solution is to abolish patents entirely through strong constitutional measures and to find other legislative instruments, less open to lobbying and rent-seeking, to foster innovation whenever there is clear evidence that laissez-faire under-supplies it." Michele Boldrin and David K. Levine, "The Case Against Patents," Federal Reserve Bank of St. Louis Working Paper Series, Working Paper 2012-035A, p. 1. Chapter 4 of their book (Michele Boldrin and David K. Levine, Against Intellectual Monopoly, a copyrighted volume published by Cambridge University Press (2008)) is entitled "The Evil of Intellectual Monopoly."

panel data sets that were compiled from patent records, biographical information about inventors, assignment transfers, lawsuits and legal treatises, and over 20,000 observations of technological prizes that were granted in Britain, France and the United States. The first section of the paper considers the general argument that patents function as inefficient monopolies. The second section highlights the role of "non-practicing entities" in early markets for invention. "Trolls" are often associated with excessive enforcement of patent rights through litigation, so the third section assesses patterns of litigation over major innovations, involving patent-related disputes and disputes in general that were reported in state and federal courts. The next section analyzes prize systems, which are being advocated as superior alternatives to patent institutions, and examines the identity of prize-winners, as well as the social consequences in the form of technological spillovers. The final section offers a brief summary conclusion.

PATENTS AND MONOPOLIES

Intellectual property has a long history, as a concept and as a policy instrument, and from its inception has been associated with controversy over the rights of exclusion they confer.[11] Economists and analysts who regard patents as state-sanctioned monopolies are more likely to consider them as unproductive or unwarranted. Statutory patent grants were introduced in England as an exception to a ban on monopolies

[11] Some scholars today claim that the term "intellectual property" comprises a "recent vogue." For instance, Mark A. Lemley has repeatedly been cited (and has repeated the same sentence in several of his articles) on this point. See "Property, Intellectual Property, and Free Riding," Texas Law Review, vol. 83 (2005), pp. 1033-4, where he states that "Patent and copyright law have been around in the United States since its origin, but only recently has the term 'intellectual property' come into vogue." However, not just the vocabulary, but the underlying concept of a property right in intangible mental output, can be found in historical materials, in contexts that suggest the term was in common usage by at least the eighteenth century. References to intellectual property are readily available in official and vernacular French and English sources, as well as in the United States. For instance, in 1769, The Monthly Review (vol. 41, p. 290) notes, "What a niggard this Doctor is of his own, and how profuse he is of other people's intellectual property." In 1807, the "New-England Association in Favour of Inventors and Discoverers, and Particularly for the Protection of Intellectual Property" was organized to further the interests of patentees and inventors (The Medical Repository, November-December, 1807-1808, p.303.) Robert R. Livingston in 1810 wrote an open letter regarding "Considerations on Mental or Intellectual Property, with Suggestions for Its Greater Security" (The Medical Repository, vol. 3 (1811), p. 1).

or pervasive privileges that the monarch sold off to raise revenues.[12] These privileges had created numerous monopolies in a wide variety of areas, from intellectual endeavours to manufactured products, as well as barriers to entry in guilds and occupations. The Commons finally succeeded in a petition that outlawed all monopolies, with the sole exception of new inventions. The resulting popular antipathy to generic royal privileges carried over to the hostile treatment of exclusive grants for inventions in the form of patent rights. For these reasons, patent grants in Britain were grudgingly granted, and their scope and enforcement narrowly construed.

British patents were granted by a registration system that did not examine the validity of applications, and anyone who paid the substantial filing fees was granted patent rights. Thus, the patent office approved the applications of wealthy importers who had not invented the devices they patented, as well as employers who chose to file for rights to the innovations their workers had created, and items that had already been in the public domain. Another important feature of the British patent system was that its rules and standards established significant barriers that deliberately limited access to property rights in invention.[13] Attitudes toward trade in patent rights were imbued with the distaste felt for speculation, and legal provisions to prevent financial bubbles and "stock jobbing" were extended to technology markets, which were as a result quite thin and limited.[14] In a reprise of arguments made today, policy was based on the assumption that too many "small" inventions would clutter up the system and create undue problems for the important discoveries. These stipulations penalized the ordinary inventor without wealth or influence who wished to obtain protection and benefit financially from his discovery.

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[12] The Statute of Monopolies in 1624 codified existing common law policies, by authorizing patent grants for fourteen years for "the sole making or working of any manner of new manufacture within this realm to the first and true inventor...so they be not contrary to the law nor mischievous to the State by raising of the prices of commodities at home, or hurt of trade, or generally inconvenient." The "first and true inventor" was interpreted to include introducers of inventions that had been created abroad, and the roster of successful patentees included employers of the actual inventor, as well as patent agents applying on behalf of their customers.

[13] The application costs were prohibitively high relative to per capita income. Inventors who wished to obtain protection throughout the realm had to contend with the bureaucracy of three patent systems, and to pay fees that ranged from £100 for an English patent to more than £300 for property rights that extended to Ireland and Scotland. The complicated system also effectively inhibited the diffusion of information and made it difficult, if not impossible, for inventors outside of London to readily conduct patent searches. See Khan, Democratization (2005).

[14] For the data that compares markets in Britain to the United States, see Khan, Democratization (2005).

The American patent system was deliberately designed to be different. Policies were based on the presumption that patents for new inventions were not true monopolies, and that social welfare coincided with the individual welfare of inventors. Instead of deprecating patentees as monopolists, courts and policy-makers regarded them as benefactors whose rights should be strongly defended. If the patent examination system worked properly, an exclusive right was awarded only to those who had created an invention that had never existed before in the world. A monopolist diverted public goods to his own selfish ends in a manner which was "justly odious," whereas patent rights had to be "most carefully guarded and protected, because it is so easily assailed."[15] Of course, the exercise of patent rights could and did often lead to market power, but that was separate from the policy implications of declarations that patent rights in themselves comprised monopolies. Two centuries of U.S. federal patent rules rejected the argument that the validity of patent rights or the attendant ability to enforce them should depend on commercialization or whether patents were "worked" or "practiced." Working requirements or compulsory licenses, standard measures of colonial legislatures to attenuate monopoly power, were regarded as unwarranted infringements of the rights of "meritorious inventors," and incompatible with the philosophy of U.S. patent grants.[16]

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[15] "Patentees are not monopolists . . . A monopolist is one who, by the exercise of the sovereign power, takes from the public that which belongs to it, and gives to the grantee and his assigns an exclusive use. On this ground monopolies are justly odious. .. Under the patent law this can never be done. No exclusive right can be granted for anything which the patentee has not invented or discovered. If he claim anything which was before known, his patent is void, so that the law repudiates a monopoly. The right of the patentee entirely rests on his invention or discovery of that which is useful, and which was not known before. And the law gives him the exclusive use of the thing invented or discovered, for a few years, as a compensation for `his ingenuity, labor, and expense in producing it.' This, then, in no sense partakes of the character of monopoly." Allen v. Hunter, 6 McLean, 303 (McLean, 1855). "Probably of all species of property, this property in patent rights should be most carefully guarded and protected, because it is so easily assailed ... Now, patents are not monopolies ... a patent is that which brings out from the realm of the mind something that never existed before, and gives it to the country," Singer v. Walmsley, 1 Fisher 558, Md. 1859.

[16] See, for example, the testimony before the Senate Committee on Patents: "One of the great virtues of our patent system has been that it has always afforded a door, open alike to the poor and the rich, by which affluence might be and occasionally is attained. A compulsory working amendment would in effect be a discrimination in favor of the rich man and the corporation and against the average inventor." (Committee on Patents, Hearings Before the Committee on Patents, U.S. Senate 67th Congress, 2nd Session, on S. 3325 and S. 3410: Washington, D.C. (1922), p. 80). For brief periods, foreigners were treated differently in this regard: the 1832 and 1836 statutes stipulated that foreigners had to exploit their patented invention within eighteen months (although the courts did not enforce the laws); and during wartime property of enemy owners was subject to liability rules (Charles Henry Huberich, The Law Relating to Trading with The Enemy: New York, Baker, Voorhis & Company (1918)).

The bargain that was struck between society and the inventor comprised the grant of an exclusive right for a limited period, in return for disclosure about the way to replicate the discovery.[17] The primary concern was access to the new information, and the ability of other inventors to benefit from the discovery either through licensing, inventing around the idea, or at expiration of the patent grant. The emphasis was certainly not on the production of goods; in fact, anyone who had previously commercialized an invention lost the right of exclusion vested in patents. The decision about how or whether the patent should be exploited remained completely within the discretion of the patentee, in the same way that the owner of physical property is allowed to determine its use or nonuse. Courts and legislators consistently and emphatically rejected calls for such restrictions as working requirements or compulsory licenses, and during international patent conventions the U.S. representatives tried to persuade other nations to follow its example .[18]

TROLLS AND PATENT INVENTIONS

A great deal of publicity and anxiety has recently been generated by the exercise of ownership rights by "patent trolls," although it is not entirely clear what the phrase represents. Most frequently, the debates refer to "non-practicing entities" (whether the inventor or an intermediary) who use licensing and litigation to extract profits from (seemingly, more meritorious) manufacturers of the product. These entities, it is argued, reduce market efficiency and social welfare because their activities impose unwarranted taxes and create disincentives for true innovators, who fear the prospects of litigation.[19] This populist attitude towards non-practicing entities bears a striking resemblance to the value-system current

[17] The court in Boulton and Watt v. Bull, 2. H. Black. 470, 16th May 1795, made the famous statement that "the specification is the price which the patentee is to pay for the monopoly." See John Davies (ed), A Collection the Most Important Cases Respecting Patents of Invention: London, W. Reed (1816), p. 176.

[18] The best discussion of such issues is still Edith Tilton Penrose, The Economics of the International Patent System, Johns Hopkins Press, 1951. Recent decisions in court, however, raise questions about how committed some groups in the the U.S. are about maintaining the longstanding policy of protecting the rights of patentees. (See, for instance, Paice LLC v. Toyota Motor Corp, 504 F.3d 1293, 2007. Paice LLC was the owner of a patent for an electric vehicle part that appropriated returns through licensing. The court denied the firm a permanent injunction against infringer Toyota and ordered remedies of "ongoing royalties" that functioned very much like compulsory licenses.)

[19] See James E. Bessen, Jennifer Laurissa Ford and Michael J. Meurer, "The Private and Social Costs of Patent Trolls," Regulation, Vol. 34, No. 4 (2012): 26-35.

two hundred years ago, wherein merit was attached only to actual production of physical goods or tilling of the soil, and profiting from trading and speculation was regarded as suspect or even immoral.[20] Such attitudes then and now deny a fundamental premise of free markets, that value is created through consensual exchange.

The economics of comparative advantage implies that output and productivity increase through specialization, the division of labour and exchange, and this is certainly the case in technology markets. All intermediaries have the ability to reduce the costs of search and exchange, to enhance liquidity, improve market depth and breadth, and to increase overall efficiency. Specialized intermediaries are especially valuable in new or emerging markets and in instances where asymmetries of information and other transactions costs are significant. One of the advantages of a system that secures and enforces property rights is that it facilitates contracts and trade, and the attendant benefits of enhanced coordination, capital mobilization, price discovery and valuation, and specialization. These precepts were acknowledge from the inception of the U.S. patent system, so it is hardly surprising that extensive national network of licensing and assignments quickly developed, aided by legal rulings that overturned contracts for useless or fraudulent patents. As a result, American inventors were able to benefit from patent markets to a far greater extent than in other countries. Intermediation facilitated the ability to divide and subdivide the rights to their idea, sometimes with great complexity, across firms, industries and regions. Successful inventors were able to leverage their reputations and underwrite the research and development costs of their inventions by offering shares in future patents. This process also promoted trade in patent rights and technological innovations across countries, and numerous American patentees succeeded in establishing multinational enterprises and dominating the global industry.[21]

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[20] The puritanical regarded financial derivatives and insurance contracts in the same light as gambling and the consumption of moonshine. Economic speculation was held to be immoral because profits were essentially based on bets about price movements, in which nothing "real" was produced. Rulings at common law refused enforcement of futures trades where actual delivery of the stock or commodity did not occur, and denied brokers recovery, while some state statutes criminalized such "wagers". See Roy Kreitner, "Speculations of Contract, or How Contract Law Stopped Worrying and Learned to Love Risk," 100 Colum. L. Rev. 1096 (2000).

[21] B. Zorina Khan, "Selling Ideas: An International Perspective on Patenting and Markets for Technology, 1790-1930," Business History Review, vol. 87 (Spring) 2013: 39–68.

Specialization and the division of labour often implied that creators differed from the marketers of inventions, producers and commercializers. The "great inventors" of the nineteenth century, who were responsible for major disruptive technological innovations, were especially likely to be "non-practicing entities." The evidence suggests that the market-orientation of the U.S. patent system was highly beneficial to these great inventors, and especially to those whose wealth would not have allowed them to directly exploit their inventions through manufacturing or other business activity.[22] For instance, Elijah McCoy (1844-1929), a black inventor who received his first patent for an automatic lubricating device in 1872, did not have enough funds to manufacture his improvements in engine lubricators, but he was able to appropriate returns by selling off the rights to most of his 14 patents. Similarly, John Francis Appleby (1840-1917) licensed and assigned his patents for agricultural binding mechanisms to companies that manufactured the machines. And, of course, according to some definitions, university professors such as Stillman W. Robinson (1838-1910), assignor of some 40 patents in engineering, also exemplify non-practicing entities.

As seen in Table 1, a remarkably high proportion of the great inventors extracted much of the income from their inventions by selling or licensing the rights to their inventive property. Moreover, it was just those groups that one would expect to be most concerned to trade their intellectual property that were indeed the most actively engaged in marketing their inventions. Specifically, it was the great inventors with only a primary school education (a proxy for financial status) who were most likely to realize appropriate the returns from their inventions through sale or licensing, whereas those with a college education in a non-technical field were generally among the least likely to follow that strategy. Overall, the reliance on sales and licensing was quite high among the first birth cohort (51.4 percent on

[22] The information for the "great inventors" is from a sample of over 400 individuals and over 6000 of their patents. The sample comprised those inventors who were featured in biographical dictionaries for their contributions to technology. For further details, see B. Zorina Khan**,** The Democratization of Invention: Patents and Copyrights in American Economic Development. NBER and Cambridge University Press (2005); B. Zorina Khan and Kenneth L. Sokoloff, "Institutions and Democratic Invention in 19th Century America," American Economic Review, vol. 94 (May) 2004: 395-401; B. Zorina Khan and Kenneth L. Sokoloff, "Institutions and Technological Innovation During Early Economic Growth: Evidence from the Great Inventors of the United States, 1790-1930," in Institutions and Economic Growth, (eds) Theo Eicher and Cecilia Garcia-Penalosa, MIT Press (2006):123-158.

average), and remained high (62.1, 44.0, and 66.0 percent in the next three cohorts), until a marked decline among the last birth cohort (those born between 1866 and 1885). The proportion of great inventors who relied extensively on sales or licensing of patented technologies then fell sharply, and there was a rise in the proportion that realized their returns through long-term associations (as either principals or employees) with a firm that directly exploited the technologies.

Naomi Lamoreaux and Kenneth Sokoloff, in a series of empirical studies, demonstrated that the experience of the great inventors was not anomalous, but was typical of the entire market in the nineteenth century.[23] They examined a large random sample of contracts that recorded the transfer of patent rights, and found that extensive and complex trades in assignments and licensing took place in secondary and tertiary markets throughout the country. Like the great inventors, many talented patentees specialized in inventive activity, and extracted returns from their efforts by taking advantage of the opportunity to delegate the exploitation of their discovery rather than engaging in manufacturing themselves. This process was facilitated by such specialized intermediaries as patent agents and attorneys, who were able to reduce the costs of transactions and searches. These intermediaries also helped inventors to mobilize venture capital and to exploit their inventions in other ways. Women inventors, in particular, benefited from the ability to exchange part of their property rights, for instance as a means of compensating intermediaries who helped with funding , advice on commercialization, and legal enforcement.[24] For instance, Maria Beasley reached an agreement in 1881 to transfer half of the

[23] See, for instance, Naomi R. Lamoreaux and Kenneth L. Sokoloff, "Market Trade in Patents and the Rise of a Class of Specialized Inventors in the Nineteenth-Century United States," American Economic Review, Papers and Proceedings, vol. 91 (May 2001):39-44; Naomi R. Lamoreaux and Kenneth L. Sokoloff, "Long-Term Change in the Organization of Inventive Activity," Proceedings of the National Academy of Sciences, vol. 93 (Nov.1996):12686-92; Naomi R. Lamoreaux, Kenneth L. Sokoloff, and Dhanoos Sutthiphisal, "The Reorganization of Inventive Activity in the United States in the Early Twentieth Century," in Understanding Long-Run Economic Growth: Geography, Institutions, and the Knowledge Economy, ed. Dora L. Costa and Naomi R. Lamoreaux, Chicago: University of Chicago Press, (2011): 235-74.

[24] B. Zorina Khan, "`Not for Ornament': Patenting Activity by Women Inventors," Journal of Interdisciplinary History, vol. 33 (2) Fall 2000: 159-195.

rights in an uncompleted invention to James Henry of Philadelphia, in return for an advance of funds to complete the machine.[25]

According to a recent Supreme Court decision, "trial courts should bear in mind that in many instances the nature of the patent being enforced and the economic function of the patent holder present considerations quite unlike earlier cases. An industry has developed in which firms use patents not as a basis for producing and selling goods but, instead, primarily for obtaining licensing fees."[26] The historical evidence refutes such claims, since "non-practising entities" or patent rights-holders who do not manufacture their inventions or final goods are hardly anomalous. Rather, as Adam Smith suggested, specialization and the division of labour are endemic to efficient markets. NPEs were the norm during the nineteenth century, and technology markets provide ample evidence that patentees who licensed or assigned their rights were typically the most productive and specialized inventors. As markets in invention became more competitive, many patentees cross-licensed their patents to other inventors to avoid the potential for conflicting rights. The distinction between patentees and licensees was often so blurred as to be meaningless since, once an inventor had a foothold in a market, he himself might become a licensee to complete his portfolio of associated patent rights and so add to his royalty stream. In some cases, patent rights were allotted to companies that intended to produce the invention or associated final goods. But in many others, "speculators" invested in patents with the sole intention of profiting from the margins of price differentials, without participating in either inventive activity or manufacturing, much as a financial investor might trade in a share in a company in secondary and tertiary markets. In so doing, they added to the liquidity and depth of the market and enabled others to minimize their exposure to risk. These different patterns all characterized a process of securitization that proved to be as fundamental to the development of technology and product markets as it was to the mobilization of financial capital.

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[25] Similarly, Jacob L. Frey of New York advertised: "Copartnerships. Attention, -- CAPITALISTS, CAPITALISTS – WANTED, a partner with the necessary capital to establish a sewing machine manufactory, with a new patented stitch; the only invention on the record of patents; would sell the patent right if desired." New York Herald, November 15, 1865, p 7. The patent in question was No. 49745, September 5, 1865, Improvement in sewing-machines.

[26] eBay Inc. v. MercExchange, L.L.C., 547 U.S. 388 (2006), 395-6.

WARLIKE PATENTEES AND EXPLOSIVE LITIGATION

Non-practicing entities are often linked to the proliferation of "patent wars" and held responsible for an "explosion" in patent litigation in recent decades.[27] The prospect of such litigation, according to some scholars, implies that patents comprise "probabilistic property rights," analogous to lottery tickets.[28] At the same time, the discussion of litigation and non-practicing entities is muddied by a lack of consistency in definitions and imprecision in the use of data.[29] If we define an "explosion" as an increase that is abnormal in a statistical sense, relative to previous trends, it is possible to identify the extent to which recent outcomes are anomalous and in need of reform. Accordingly, this section offers an empirical assessment of patent wars and litigation patterns over the past two centuries.

Americans from the beginning of the colonial period have always considered themselves to be exceptionally litigious, and equally hyperbolic about decrying its consequences. Litigation is a function of many factors, including changes in legal rules, uncertainty, conflicting interpretations of rights and obligations, defensive and aggressive measures, and the scale of the underlying market. One of the most straightforward explanations of the volume of patent lawsuits is related to the numbers of patents filed. Figures 1(a) and (b) support the hypothesis that the "patent litigation explosion" merely mirrors a parallel "explosion" in patenting. Patent applications and grants alike have risen sharply, from approximately 270,000 applications and 153,000 grants in 1999, to 543,000 and 253,000 respectively in 2012, with

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[27] Darren Cahr and Ira Kalina, "Of PACs and Trolls: How the Patent Wars May Be Coming to a Hospital Near You," Health Law. 19 (2006): 15; F. Warshofsky, The Patent Wars: The Battle to Own the World's Technology, New York: Wiley (1994); Adam B. Jaffe and Josh Lerner, Innovation and its discontents: How our broken patent system is endangering innovation and progress, and what to do about it, Princeton University Press (2011). James Bessen and Michael J. Meurer, "The patent litigation explosion," Boston University School of Law Working Paper 05-18 (2005): 10.

[28] Mark A. Lemley and Carl Shapiro, "Probabilistic Patents," Journal of Economic Perspectives, 19(2) 2005: 75 – 98.

[29] For instance, Hagiu and Yoffie define NPEs narrowly as intermediaries who do not innovate themselves, nor produce output. They claim that NPEs in 2011 filed 1211 lawsuits, citing a website, PatentFreedom.com. However, by their definition that number is inaccurate, since PatentFreedom (the source for their litigation data) defines an NPE very broadly as "any entity that earns or plans to earn the majority of its revenues from the licensing or enforcement of its patents." (Andrei Hagiu and David B. Yoffie, "The New Patent Intermediaries: Platforms, Defensive Aggregators, and Super-Aggregators," Journal of Economic Perspectives, 27(1) 2013: 45-66; and PatentFreedom.com at https://www.patentfreedom.com/about-npes/background/).

especially rapid growth between 2009 and 2010. Opinions may differ but, although it has increased over the past few years, the rate of litigation (cases as a percentage of patents), is still unexceptional. This is especially true since changes in legal rules (ironically intended to reduce litigation) have led to a nominal or administrative increase in the numbers of cases filed in the most recent years.[30]

However, two decades may be insufficient to assess whether patent disputes have reached a pathological level. We therefore estimate the long run patterns for patenting and litigation, between 1790 and 2012. Figure 2 shows patent grants per capita over the two centuries of the existence of the federal patent system, for total patents and patents filed by domestic residents. It suggests that the "long nineteenth century" was an extraordinarily creative period in terms of patented innovations, when the numbers of patents relative to population attained levels that have not been exceeded until the final three years. Figure 3 presents the patterns over time of reported patent cases relative to patents between 1790 to 2000.[31] This historical trend in litigation rates relative to patents granted clearly does not support claims that litigation in the past decade has "exploded" above the long term norm. In fact, the per patent rate of litigation was highest in the era before the Civil War and during the subsequent market expansion that started in the 1870s. Patent litigation rates were increasing toward the end of the twentieth century, but the increase comprised a return toward the long-term norm.

For many commentators today, the nature of modern technologies is sufficiently unique that they raise issues that are different from prior eras.[32] Technological innovations in the 21st century have

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[30] Section 19 of the Leahy-Smith America Invents Act of 2011(35 U.S.C. § 299) restricts the ability of plaintiffs to join multiple defendants in infringement actions. Even before the passage of the legislation, some litigants may have filed earlier in anticipation of such rules.

[31] It should be noted that the published official judicial statistics of patent litigation are not available for this entire period, so they cannot be used to gauge long run trends and are not directly comparable to the results in Figure 1. For the sources of the data in this section, see the footnotes to the Figures.

[32] One referee points to the claims that information technology stands out because "The patents are hard to find, hard to determine their limits (so freedom to operate is hard to determine). The upfront costs of programming is low (less need for incentives) and most programming starts from scratch, so almost all the invention is independent (ie no free riding). Thus, infringement is almost always inadvertent. Finally, most marketable products encompass 1000s of patents (so multiple opportunities for trolling)." However, these differences are of degree rather than of kind: patents have always belonged to "the metaphysics of the law" and it is no easier to identify the boundaries of an electrical innovation; some forms of software have extremely high fixed costs and other nonsoftware inventions also have low costs; most programming does not "start from scratch" and is certainly not independent of other discoveries; and inventions such as the sewing machine or automobile comprised thousands of patented incremental

undoubtedly transformed production and consumption; however, their economic and institutional impact are arguably hardly comparable to those of the first century of the patent system.[33] This was not just true of "great inventions" but also of supposedly incremental discoveries such as safety pins, aspirin and manufactured soap. From the perspective of a world where mail was delivered by stagecoach, the advent of the telegraph was far more transformative to communications in the antebellum era than the change from a landline to a cellphone. The principles that were being patented were likewise more radical and difficult for juries and judges of the day to comprehend and distinguish among competing claimants. Electrical inventions such as the polyphase alternating current system that would exploit the power of Niagara Falls to illuminate regions hundreds of miles away were so abstract and incomprehensible that these discoveries seemed magical even to trained observers.[34]

Accordingly, every new innovation that mattered in the marketplace brought uncertainties, conflicts and consequences that were initially processed in state and federal courts, until these issues were resolved through various institutional mechanisms. Such disputes did not only relate to questions of patent rights, but surrounded all forms of claims that were resolved in the courts. Figure 4 shows new innovations like the telegraph, telephone and automobile were inevitably accompanied by an upswing in total civil litigation. As one noted jurist observed, "the great inventions that embodied the power of steam and electricity, the railroad and the steamship, the telegraph and the telephone, have built up new customs and new law."[35] Total disputes about property, contract, torts, and other forms of civil litigation typically followed a quadratic pattern, in which litigation rapidly increased during the early expansion in markets

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inventions. Information technology does not involve or require dramatically new analysis in the realm of patent rights.

[33] See, for instance, Robert J. Gordon, "Does The 'New Economy' Measure Up To The Great Inventions Of The Past?," Journal of Economic Perspectives, 2000, v14(4,Fall), 49-74.

[34] According to a reporter of the day, the inventions of such patentees as Nikola Tesla "seem like the dream of an intoxicated god" (cited in James O'Neill, Prodigal genius: the life of Nikola Tesla, Book Tree (2007), p. 7). The court in Edison Electric Co. v. Westinghouse (55 F. 490, 1893) noted its difficulty in less poetic terms: "it is exceedingly hazardous for one not an expert to express an opinion on a question so wholly within the domain of scientific exposition. … It is difficult -- impossible, perhaps -- to describe what invention is."

[35] Benjamin N. Cardozo, The Nature of the Judicial Process, New Haven, CT (1921), p. 62.

for the new innovation, but subsequently declined as institutions adjusted to the technological disruptions.[36]

To foreign observers, it seemed that in the United States "every good thing deserving a patent was patented."[37] Enormous profits awaited those who were able to successfully commercialize new inventions and satisfy or anticipate market demand, creating wealth for some entrepreneurs on a scale that was unprecedented then or since. Numerous inventors were attempting to resolve similar problems, leading to multiple patent interferences, overlapping claims, and efforts to invent around existing patents. Complex combinations of hundreds of patents often covered any particular device, so it is not surprising that intense competition for these excess returns centered around these rights.[38] Licensing and litigation comprised a common strategy by "practicing" and "non-practicing entities" alike. Austin and Zebulon Parker of Ohio prosecuted claims for licenses against millers across the nation and engaged in countless lawsuits regarding an 1829 patent for an improved waterwheel. George Campbell Carson's smelting patents were held to be worth an estimated $260 million in damages and royalties and he floated shares in the Carson Investment Company, which was formed to pursue potential defendants.[39] In the railroad industry "… a ring of patent speculators, who, with plenty of capital, brains, legal talent and impudence, have already succeeded in levying heavy sums upon every considerable railway company in the land… This case is not an isolated one, but there were hundreds of them, and the railway company that made up

[36] A more detailed exposition is available in B. Zorina Khan, "Innovations in Law and Technology, 1790-1920," in Cambridge History of Law in America, (eds) Michael Grossberg and Christopher Tomlins, New York: Cambridge University Press (vol. II, 2008): 483-530, 796-801.

[37] Sir William Thompson, President of the Mathematical and Physical Section of the British Association, cited in Appendix to Bally (1878), p. 50.

[38] "It may be that there are half a dozen patents on some individual section of the machinery, half a dozen ideas so interwoven that while by analysis you can separate one from the other, you can not in looking at the section pick out one patented combination without seeing at the same time two or three more patented combinations interwoven with it. No machine that is of any great consequence is protected by a single patent. That is not the way things work out, and it is not a condition that arises in manufacturing to a practical extent."
"The result is that even if a manufacturer has a patent which might be used on a particular machine made by him, but which for any reason is not used, no other manufacturer could by obtaining the right to use the patent in question incorporate it into that machine without at the same time obtaining the right to use a number of other patents which are used in the machine." (Committee on Patents, Hearings Before the Committee on Patents, U.S. Senate 67th Congress, 2nd Session, on S. 3325 and S. 3410: Washington, D.C. (1922), p. 180).

[39] Los Angeles Times, 17 Feb 1925, p. 1. Carson sold off 75 percent of the shares in the company, and retained the rest.

its mind to insist upon its rights had to keep a large legal force, a corps of mechanical experts, and other expensive accessories, in order to secure that end."[40]

One of the most contentious examples involved the 1828 Woodworth patent, which attracted public attention and outrage for almost three decades.[41] Woodworth was a carpenter from New York whose improvement on machines to plane wood dramatically improved productivity in the woodworking industry. Since he did not have the resources to finance the patent or commercialize his invention, Woodworth initially transferred half of the rights to a backer, but ultimately sold off all of the rights to members of a wealthy syndicate who intended to divide and repackage the patent rights for resale.[42] These investors obtained several million dollars in annual profits after they assigned geographic rights to the patent throughout the United States, and licensed use-rights to mills at royalty rates of as much as 25 percent.[43] Woodworth died in 1839, but the patent lived on for another seventeen years, because the owners of the patent rights successfully lobbied Congress for an extension in the life of the patent until

[40] Railway Times (1860-1872)22.29 (Jul 16, 1870): 231.

[41] U.S. Patent No. X5,315, Dec. 27, 1828. B. Zorina Khan, "Property Rights and Patent Litigation in Early Nineteenth-Century America," Journal of Economic History, vol. 55 (1) 1995: 58-97.

[42] The congressional hearings includes many interesting insights into markets of the day. Congress was besieged with hundreds of petitions regarding the extension of the Woodworth patent, which the hearings committee (p. 179) deemed "the most onerous burden of taxation for the benefit of a single man which was ever inflicted upon the country." See Committee on Patents, "Woodworth Patent," H. Rep. No. 156, 32nd Congress, 1st Session (1852). A special meeting in Philadelphia among those who opposed the extension noted that "the great and extensive demand for such machinery … has enabled the owners of this patent to demand enormous sums from the various kinds of mechanics using such machinery, which they must pay, or incur the hazard of litigation." ("The Woodworth Patent," Scientific American, Volume 5, Issue 30 (1850), p. 237.)

[43] The relative value of the annual income from the patent to the investors in terms of dollars today ranges from $327 million (simple inflation adjustments) to more than $94 billion (in terms of wage equivalents) . The network of secondary and tertiary trades was minute and complicated, and the complexity increased after the term of the patent was extended several times, given that investments had been made with the anticipation that the patent was about to expire. William Woodworth first of all sold a half-share in his rights to James Strong for $1500, which Woodworth used to finance the patent. Another inventor, Uri Emmons, was granted a patent for a similar machine in 1829, which he assigned to Toogood, Halstead, and Tyack. In order to avoid litigation, the patents in question were cross-assigned to all of the parties concerned, in the relevant overlapping geographic regions of the United States. Woodworth invented additional improvements and, after his death, these patents rights belonged to his estate. In 1843, Woodworth's son made a partial assignment of the rights to the seven-year extension to James G. Wilson, "a private speculator" who was a party in the Supreme Court case Wilson v. Rousseau, 45 U.S. 646 (1846). The patent law, namely § 18 of the statute of July the 4th, 1836, 5 Stat. 124, provided that the benefit of the renewal extended to assignees and grantees. However, courts differed in their interpretation of the statute, and the justices in Wilson v. Rousseau referred with some disdain to these early non-practicing entities, who wished to benefit long after the death of the patentee, as investors who "dealt with the patent rights as a matter of business and speculation." See B. Zorina Khan, "Property Rights and Patent Litigation in Early Nineteenth-Century America," Journal of Economic History, vol. 55 (1) 1995: 58-97.

1856. These assignees were involved in countless disputes and a total of 78 reported lawsuits across the country, many to suppress competing patent owners, and they typically won significant damages and even permanent injunctions. So it is somewhat incongruous that their petition to extend the patent was partly on the grounds that the cost of litigation had dissipated the profits from the invention, so they needed the extra concessions to appropriate just returns.[44]

The network of inventive rights, litigation, and controversy that characterized the Woodworth patent was hardly unique.[45] "Patent wars" were waged in expanding markets in shoe-making, reapers and other agricultural machinery, india rubber products, motion pictures, early aviation, radio, electricity and telecommunications.[46] At the same time, the government exercised fewer constraints on the behavior of industrial and technological rivals than in the modern era, and some of these conflicts even resulted in outright criminal behavior such as bribes, spying, payoffs and physical violence .[47] "Practicing" did not necessarily confer virtue on the relevant party, and neither did patentee-status. Many manufacturers obtained the rights to rival patents, to add to their income, to foreclose on competition, or to protect themselves from the prospect of litigation. George Selden, a patent attorney, was never successful as a manufacturer, but propelled his 1895 patent (No. 549160) for gasoline-powered vehicles through the courts for eight years in the attempt to extract royalties from every car that was produced in the country, until Henry Ford managed to overturn his claims. Charles A. Shaw, patentee of an alleged 100

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[44] In a similar case, John C. Birdsell invented in 1858 an improvement on clover threshing machines that was extended for a term of twenty one years, during which time his rights were infringed upon by a pool of powerful manufacturers of agricultural implements. He appealed to Congress for a further extension on the grounds that, although he had earned over $40 million on the patent, his costs from litigation and other sources prevented him from profiting over the two decades. In 1878 it was alleged that he had spent $3.2 million dollars in attorney fees. Indianapolis Sentinel, vol. XXVII, No. 303, October 31, 1878, p. 3.

[45] The Morning Star, June 3, 1891, p. 2, quipped: "In reply to the question: "What is a patent?" the Yankee inventor once said: "It is the right to sue somebody.""

[46] "Scarcely any great invention is made in this country without a lawsuit to obstruct its development. This is as true of the telephone as of the aeroplane," Oregonian, vol. LII; Issue 16170, September 21 1912, p. 6. The Wrights were so assiduous in enforcing their rights that the French aviator, Louis Paulhan, was served with a lawsuit the moment he landed in the United States, alleging that his aircraft infringed on the Wright patents. For an account of the sewing machine wars, see Adam Mossoff, "The Rise and Fall of the First American Patent Thicket: The Sewing Machine War of the 1850s," Arizona Law Review, Vol. 53 (2011): 165-211.

[47] Alpheus Gallahue, patentee of shoe pegging machinery apparently offered an annual stipend of $1.1 million to another patentee, B. F. Sturtevant, if he agreed to lobby for the extension of Gallahue's profitable patent. National Aegis, Nov. 7 (1874), p. 3. In one amusing report, a clergyman was arrested for assaulting a patent agent who questioned the validity of his right to a patent for his invention (New York Times, 17 Oct 1888, p. 8.)

inventions, purchased other patent rights as investments, and was continually involved in litigation on account of this portfolio of patents. Shaw and Clark, a famous sewing machine enterprise located in Biddeford, Maine, successfully resisted the combined efforts of Elias Howe, Wheeler & Wilson, Grover & Baker, and Singer & Co., and ended up with a lucrative stream of income from licenses in the sewing machine market.

In short, "vexatious" and costly litigation about all areas of law -- patents, property, contracts and torts alike -- were inevitably associated with the advent of important innovations, and the moral here is that it is not possible to pre-assign labels that would predict who would act in a meritorious fashion and who would engage in unproductive behavior to drive out competitors.[48] The "great india rubber lawsuits" featured intense rivalry among Horace Day, Charles Goodyear and Nathaniel Hayward, and resulted in litigation costs of more than $18 million (current dollars). Cyrus McCormick, Thomas Edison, King Gillette, George Westinghouse, and Alexander G. Bell were just a few patentees who engaged in multiple disputes with prohibitively high litigation costs. The legal profession certainly benefited from these confrontations and in one lawsuit alone in 1852, Daniel Webster was paid $332,000 as lead attorney.[49] A "big radio lawsuit" was litigated all the way to the Supreme Court in 1928, and the De Forest Company was finally awarded the rights in an interference over feed-back circuit patents, but at a cost of over $10 million in litigation expenses.[50] The sums that were at stake in litigation between these pioneer enterprises were especially impressive when considered relative to average income or earnings. For instance, U.S. Steel and Bethlehem Steel were involved in a 1929 lawsuit over the Gray Beam patent, in which $10.6 billion, relative to the wages of an unskilled worker, were at issue. Some firms were

[48] "The amount of money used in litigation, and the threats which have been employed by patent capitalists to over-awe the less wealthy or more timorous persons engaged in the same business, have been the means of depreciating the value of patent property in general. … Many who would gladly purchase patents and engage in the manufacture of the articles protected by them, have been prevented from doing so by fears of being involved in vexatious lawsuits." Scientific American, No. 10, Nov 19 (1853), p. 77.

[49] The Pittsfield Sun, vol. LVI, issue No. 2896, March 20 1856, p. 1. Abraham Lincoln's political campaign was underwritten by the $25,000 (current dollars) payment he received for his silent participation in the litigation between Cyrus McCormick and John Manny, which included such luminaries as Edwin Stanton. "Battles of the Reaper Kings. Lincoln's Candidacy the Result of Reaper Patent Wars," Morning Olympian, vol. 17, No. 237, December 29, 1907, p. 3.

[50] The Washington Post, 11 Nov 1928, p. A5.

sufficiently "bumptious" that they did not hesitate to launch threats of lawsuits even against the U.S. government.[51] In response, multiple defendants at times joined together as a class and pooled resources to counter threats of litigation by a plaintiff, to overturn the validity of the patent, or to defeat attempts to extend the term of a valuable patent.[52]

Litigation rates varied by industry, and were correlated with the advent of the latest technologies. The most prolific disputes occurred in the electricity and telecommunications industry, which accounted for over 40 percent of all lawsuits filed by the great inventors around the time of the Second Industrial Revolution. The Brush and U.S. Electric Lighting Companies even threatened the customers of their competitors that purchasing these rival products was tantamount to "buying a lawsuit."[53] These lawsuits and counter-suits proved to be so expensive, that the firms eventually agreed in 1896 to end the "electric patent war" through mutual cross-licenses.[54] However, it was not long before many of the same companies -- AT&T, Radio Corporation, Westinghouse and General Electric – were directing resources towards a "battle of the air" over early wireless technology that was equally costly, and also ended in pooled interests.[55] Other patent lawsuits wound their way through the courts for years, such as the Knibbs valve patent, which was involved in litigation for 23 years, and the "mammoth patent lawsuit" over Henry Burden's 1840 spike patent which lasted over a decade and yielded "golden nest eggs" to the attorneys.[56] These epic confrontations over the rights to the wealth generated by the modern technologies captivated

[51] The term "bumptious" is applied in a report published in Springfield Republican, April 15, 1883, p. 1.
[52] Contingent fees comprised another way in which both parties could fund their costs. David L. Schwartz points to "The Rise of Contingent Fee Representation in Patent Litigation," 64 Alabama Law Review 335 (2012). However, the use of contingent fees has a much longer history, from the disapproval of "barratry" in England to their adoption in the United States quite early in the nineteenth century, as a means of democratizing access to courts for impecunious litigants. See, for instance, Stephan Landsman, "The History of Contingency and the Contingency of History," DePaul Law Review, vol. 47 (2) 1998.
[53] Philadelphia Inquirer, vol. CXI , July 31, 1884, p. 2.
[54] "The End of an Electric Patent War," Scientific American, No. 12. (Mar 21, 1896), p. 183.
[55] "Battle of the Air Developing a Mass of Litigation Which May Bring Congressional Legislation," Wall Street Journal, 12 Mar 1924, p. 10. "The Patent Pool for Radio," New York Times, 12 July 1931, p. XX9: "... patent pool will bring freedom from the throes of litigation…These conditions have permitted owners of patents to harass the industry, putting its members to millions of dollars of unnecessary litigation expense and extorting from them additional millions for royalties under patents which the courts have ultimately declared invalid."
[56] "Mammoth Patent Lawsuit," Scientific American, No. 39., Jun 4, 1859, 325.

the public imagination, and even motivated some scam artists to concoct financial ventures offering shares in patent litigation claims that they offered to float to the general public.

INNOVATION WITHOUT PATENTS?

As the preceding pages indicate, from their very inception patents and the enforcement of their rights have always been associated with debates and denials of the efficacy of "legal monopolies" for inventions, and appeals for their replacement with alternative policy instruments. In the second half of the nineteenth century the "patent controversy" in Europe included calls for reforms that ranged from changes in the subject matter and scope of patents to the abolition of patent systems.[57] Just as today, European economists who favoured the overturn of patent laws declared that patents of invention harmed social welfare. The abolitionists' justified their position by appealing to the benefits of free trade and competition, and declared that patents belonged to an anticompetitive and protectionist strategy analogous to tariffs on imports. Free access to information about new discoveries would spread quickly and benefit the entire industry. As for incentives, some inventive activity was exogenous and would occur anyway, whereas measures other than monopoly rights could be devised to encourage the rest of the profession. Inventors could be rewarded by alternative policies, such as prizes, stipends or honours from the government, an enhanced reputation, or through payments from private industry or associations formed for that purpose. Firms could benefit from trade secrecy, or simply through the lead time that the first inventor acquired over competitors by virtue of his prior knowledge.

The experience of Switzerland and the Netherlands is often cited to support the position that patent laws do not contribute to, or even hinder, innovation.[58] The Swiss cantons did not adopt patent protection until 1888, with an extension in the scope of coverage in 1907; whereas Holland repealed its patent legislation between 1869 and 1912. The Netherlands and Switzerland were initially able to benefit

[57] Fritz Machlup and Edith Penrose, "The Patent Controversy in the Nineteenth Century," Journal of Economic History, vol. 10 (1) 1950: 1–29.
[58] Much of this discussion is drawn from B. Zorina Khan, The Democratization of Invention: Patents and Copyrights in American Economic Development, NBER and Cambridge University Press (2005).

from their ability to free-ride on the investments that other countries had made in technological advances. As for the cost of lower incentives for discoveries by domestic inventors, the Netherlands was never vaunted as a leader in technological innovation, and this is reflected in their low per capita patenting rates both before and after the period without patent laws. They recorded a total of only 4561 patents in the entire period from 1800 to 1869 and, even after adjusting for population, the Dutch patenting rate in 1869 was a mere 13.4 percent of the U.S. patenting rate. Moreover, between 1851 and 1865 88.6 percent of patents in the Netherlands had been granted to foreigners. Thus, the Netherlands had little reason to adopt patent protection, except for external political pressures and the possibility that some types of foreign investment might be deterred.

The case was somewhat different for Switzerland, which was noted for being innovative, but in a narrow range of pursuits whose subject matter was for the most part not patentable. Since the scale of output and market size were very small, much of Swiss industry generated few incentives for mechanical invention.[59] The industries in which the Swiss excelled, such as hand-made watches, quality chocolates and premium food products, were less susceptible to patent protection. For instance, despite the much larger consumer market in the United States, during the entire nineteenth century fewer than 300 U.S. patents related to chocolate composition or production. Swiss watches were renowned for their fine workmanship and the quality of their designs, rather than for novel discoveries that might be capable of being patented.[60] Further, as long as the industry remained artisanal improvements in pursuits such as watch-making could be readily protected by trade secrecy. However, with increased mechanization and worker mobility, secrecy would ultimately prove to be ineffective, and inventors would be less able to appropriate returns. Patent rights were also useful in the market process of turning a new discovery into a

[59] Bally, p. 34: "We must introduce the patent system. All our production is, more or less, a simple copy. The inventor has no profit to expect from his invention, no matter how useful it may be… The want of protection for new inventions is a great disadvantage to us."

[60] An examination of Swiss entries at international exhibitions indicates that many prizes were awarded for workmanship and design rather than novel inventive ideas. According to one observer, "Chronometers, clocks, watches, &c., of great variety and great excellence, were exhibited. England, France and Switzerland were the most extensive exhibitors. The novelties were improved designs rather than new movements." Benjamin Pierce Johnson, Report on International Exhibition of Industry and Art, London, 1862, Albany, NY (1863), p. 74.

workable mechanism, which often required numerous incremental adjustments and improvements that often came from other interested parties. Finally, the right to protect one's contributions released the information into the public domain, enhanced the human capital of workmen, and allowed the pace of the entire industry to accelerate.[61]

It is therefore not surprising that, after examining the American experience, Switzerland later decided to adopt patent laws, and to model them after the United States institutions.[62] Prominent Swiss manufacturers, like Edward Dubied and Edward Bally, the Swiss Commissioners to the Philadelphia Exhibition, studied the state of technological innovation across countries and recommended "the institution of patents as the first and indispensable measure" for becoming competitive with American industry.[63] Dubied was especially admiring of the ability of specialized technology markets to permit U.S. patentees to become non-practicing entities, and to contribute their inventive capital to new enterprises on the same basis as stockholders could contribute financial capital.[64] American inventors had already obtained more than 2068 patents on watches by 1890, and the U.S. watchmaking industry benefited from mechanization and strong economies of scale that led to rapidly falling prices of output, making them more competitive internationally. In short, the rates of technical and industrial progress in the United States were more rapid than in Switzerland, and technological change was rendering Swiss artisanal methods obsolete in products with mass markets.

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[61] See the Preface of the Translator, in Bally, pp. vii-viii, xii, stating that the Swiss feared the competition of the United States because of "the progress made in those other pursuits where patented improvements had multiplied the capacity of the workman… The connection between the efficiency of the patent law, industrial progress and foreign exports, is not a new notion."

[62] Contemporaries thought the logic was self-evident: "It is in this country, where patents are numerous and easily obtained, that improved machines and processes are most rapidly introduced, as in textile manufactures, in watch-making, and shoe-making; and not in Switzerland, where until recently no patents have been granted, or in England and Germany, where patents have been hard to get." James Richardson, "Our Patent System and What We Owe to It," The Century Magazine, November 1878: 99-110, p. 104.

[63] Edward Bally, Industry and Manufactures in the United States: Look Out for Yourselves! (Addressed to Swiss Manufacturers, and Suggested by the Centennial Exhibition of Philadelphia), Boston: Beacon Press (1878). Edward Bally was the Swiss commissioner to the Centennial Exposition and one of the most prominent shoe manufacturers in Europe. He called for the adoption of patent laws and concluded that "We have but one thing to do, if we will avoid entire decadence of our industry, and that is to imitate the Americans" (p. 23). Dubied's cited view appears in his report, in Bally, p. 34.

[64] Dubied in Bally, p. 32.

What was the impact of the introduction of patent protection in Switzerland? Foreign inventors could obtain patents in the United States regardless of the legislation in their country of origin, so we can approach this question tangentially by examining the patterns of patenting in the United States by Swiss residents before and after the 1888 reforms. Between 1836 and 1888, Swiss residents obtained a grand total of 585 patents in the United States. Fully a third of these patents were for watches and music boxes, and only six were for textiles or dyeing, industries in which Switzerland was regarded as competitive early on. After the patent reforms, the rate of Swiss patenting in the United States immediately increased.[65] U.S. statutes required worldwide novelty, and patents could not be granted for discoveries that had been in prior use, so the increase was not due to a backlog of trade secrets that were now patented. It is possible, of course, that the sustained increase in patenting (and citations) after the laws were introduced in 1888 was merely coincidental or that the reforms were adopted because they anticipated such increases. Interpretations of these patterns may vary, but it is plausible that the higher rates of patenting reflected rates of inventive activity that were induced by patent protection.

Moreover, the introduction of Swiss patent laws also affected the direction of inventions that Swiss residents patented in the United States. After the passage of the law, such patents covered a much broader range of inventions, including gas generators, textile machines, explosives, turbines, paints and dyes, and drawing instruments and lamps. The relative importance of watches and music boxes immediately fell from about a third before the reforms to 6.2 percent and 2.1 percent respectively in the 1890s, and even further to 3.8 percent and 0.3 percent between 1900 and 1909. Another indication that international patenting was not entirely unconnected to domestic Swiss inventions can be discerned from the fraction of Swiss patents (filed in the U.S.) that related to process innovations. Before 1888, 21 percent of the patent specifications mentioned a process. Between 1888 and 1907, the Swiss statutes included the requirement that patents should include mechanical models, which precluded patenting of

[65] Swiss patentees obtained an annual average of 32.8 patents in the United States in the decade before the patent law was enacted in Switzerland. After the Swiss allowed patenting, this figure increased to an average of 111 each year in the following six years, and in the period between 1895 to 1900 a total of 821 Swiss patents were filed in the United States. The decadal rate of patenting per million residents increased from 111.8 for the ten years up to the reforms, to 451 per million residents in the 1890s, 513 in the 1900s, 458 in the 1910s and 684 in the 1920s.

pure processes. The fraction of specifications of Swiss patents in the U.S. that mentioned a process fell during the period between 1888 and 1907, but returned to 22 percent when the Swiss restriction was modified in 1907.

Some scholars suggest that Swiss performance at international exhibitions such as the Crystal Palace Exhibition of 1851 support the claim that patent laws are unnecessary or even hinder technological progress.[66] That conclusion is certainly inconsistent with the contemporary reports of the Swiss Commissioners to the Centennial Exhibition.[67] The official records of the Crystal Palace Exhibition similarly indicate that Switzerland was noted for skill and design rather than creativity at new and useful inventions that might qualify for patent protection. The Swiss delegation was represented by 263 exhibitors out of a total of almost 14,000 exhibitors at this event. Their display included six machines, whereas most of their exhibits were artisanal consumer final goods: watches, music boxes and musical instruments, an assortment of fabric and sewed goods such as embroidered handkerchiefs, and a host of miscellaneous items that were inherently unpatentable.[68] Only two of the prizes that the Swiss obtained were associated with the type of novelty that was required of patentable inventions.[69] The Swiss contingent won 1.5 percent of medals awarded, roughly the same as their proportion of all exhibitors, as was the case for most European nations.

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[66] See, for example, Petra Moser, "How Do Patent Laws Influence Innovation? Evidence from Nineteenth-Century World's Fairs," American Economic Review, vol. 95 (4) 2005: 1214-1236.

[67] Edward Bally, Industry and Manufactures in the United States: Look Out for Yourselves! (Addressed to Swiss Manufacturers, and Suggested by the Centennial Exhibition of Philadelphia), Boston: Beacon Press (1878). Edward Bally was the Swiss commissioner to the Centennial Exposition and one of the most prominent shoe manufacturers in Europe.

[68] The roster included paintings, "a double American rifle," gemstones, lace, fringed shawls, miniature milk tubs, goat skins, cow bells, embossed drinking cups, wood carvings, and a watch-stand "made by a pupil of the Asylum for the Blind." These are not isolated examples, but rather are representative of the entire list of the Swiss exhibits. See The Official Catalogue of the Great Exhibition of the Works of Industry of All Nations, London: Clowes & Sons (1851).

[69] At the Crystal Palace, three types of awards were given: Council medals; prize medals; and honourable mentions. The Council medals rewarded novelty (although in several cases they were given for other reasons, such as beauty and cheapness of the good.) The criteria for the other prize medals and honourable mentions did not include novelty. (See Commissioners to the Exhibition, Reports by the Juries, London: Clowes & Sons (1852).) Instead, juries were instructed to give prizes for criteria that had little or nothing to do with technological inventiveness or patentability, such as beauty of design and appearance, "adaptability to use, economy in first cost, durability, economy of maintenance, excellency (sic) of workmanship, strength." (Robert H. Thurston, discussing the Crystal Palace, in Report of the Commissioners of the United States to the International Exhibition Held at Vienna, 1873, vol. 1, p. 42: Washington, DC (1874)).

It should be further noted that international exhibitions are unlikely to be representative of the inventive capital in individual countries.[70] In the first place, the size and content of the exhibition for any country was determined in part by distance and political expedience rather than by random draws from the underlying population of inventions in the nation. Thus, at the 1851 Crystal Palace event, Britain and its dependents accounted for 7381 exhibitors (53 percent) but there were only 12 delegates from the entire continent of South America; at the Paris Universal Exhibition of 1855, by way of contrast, France and its dependents comprised 50.1 percent of all 21,779 exhibitors, Britain and its colonies were a mere 15 percent.[71] Even if we adjust for the "home court advantage," there are significant differences in participation within and across countries that are uncorrelated with technological capability. The rules and the fees differed in each of the international fairs in ways that affected participation. The funding for the exhibitions, as well as for travel and other expenses influenced the number and composition of the

[70] Counting patents relative to all exhibits is unlikely to give much insight into technological capability across countries or other units of aggregation. Numerous items on display were not patentable, and significant numbers of the exhibits were not technical inventions, ranging from agricultural output such as fresh fruit and vegetables, to minerals and wax flowers, and final goods that illustrated workmanship or design elements. Exhibitors tended to be firms or commercializers, rather than inventors, so it is impossible to determine whether many of the items had been patented. "Juries will reward an important Machine without undertaking to pronounce whether the novelties exhibited in its construction have been originated by the Exhibitor, or have been borrowed or adapted by him from some one else" (Commissioners to the Exhibition, Reports by the Juries, London: Clowes & Sons (1852), p. xxv). Contemporary observers noted that a number of the foreign entries were actually copies of articles invented and patented in the United States. (See e.g., Benjamin Pierce Johnson, Report on International Exhibition of Industry and Art, London, Albany, NY (1863), p. 11: "We found machines on exhibition from the continent, and to which prizes were awarded for their superiority, copied entirely from American machines which had been purchased in this country, and exhibited as the invention of another country.")
Without a time-limited test of novelty, counts of exhibits cannot be usefully compared across countries or fairs: "It has not been made a condition in the admission of Articles to the Exhibition that they should be new… It appears to the Commissioners that… fourteen to fifteen years… would form a limit, beyond which the claims should not be admitted." Commissioners to the Exhibition, Reports by the Juries, London: Clowes & Sons (1852), p. xxv. In many exhibitions the award of a prize was not indicative of ranking of inventive merit, the percentage of prizes tended to be proportionate to the exhibitors, and above fifty percent of exhibits typically received recognition of one sort or another. Many of the Judges at industrial fairs were chosen because of their personal prestige rather than because they were familiar with the latest technologies and, even if qualified, differences in language and personal tastes complicated the decision-making process.

[71] At the 1851 Crystal Palace event, Britain and its dependents accounted for 7381 or 53 percent of all exhibitors, in comparison to 12 exhibitors from the entire continent of South America, 30 exhibitors or 0.2 percent from China, 12.3 percent were from France, 1.9 percent (263 exhibitors) from Switzerland, and 499 or 3.6 percent from the United States. At the Paris Universal Exhibition of 1855, by way of contrast, France and its dependents comprised 50.1 percent of all 21,779 exhibitors, Britain and its colonies were a mere 15 percent, Switzerland still a modest 1.9 percent, the United States 0.6 percent (the same as the Greek contingent). These data were obtained from Great Britain, Imperial Commission, Catalogue of the British Section: Paris Universal Exhibition (1868) and various official reports on the exhibitions.

displays, since financing of some exhibitions derived from private initiative and others were funded by state and national governments. For instance, the United States was in the middle of a war at the time of the Paris Universal Exhibition of 1862, and Congress did not allot the funds requested, so only 128 Americans participated among the total of 26,348 exhibitors.[72]

In short, although the Swiss experience is often cited as proof of the redundancy of patent protection, the limitations of this special case and the difficulty of obtaining systematic measures of inventiveness should be taken into account. The domestic market was quite small and offered minimal opportunity or inducements for inventors to take advantage of economies of scale or cost-reducing innovations. Manufacturing tended to cluster in a few industries where inventive activity and innovation were largely irrelevant, such as premium chocolates, or in artisanal production that was susceptible to trade secrecy, such as watches and music boxes. In other areas, notably chemicals, dyes and pharmaceuticals, Swiss industries were export-oriented, but even today their output tends to be quite specialized and high-valued rather than mass-produced. The scanty systematic data on Switzerland are inadequate, but weakly suggest that the introduction of patent rights was accompanied by changes in the rate and direction of inventive activity. The most telling evidence is that Swiss producers themselves were concerned about their loss in competitiveness and were eager to adopt patent laws that emulated the American model. In any event, both the Netherlands and Switzerland featured unique circumstances that seem to hold few lessons for developing countries today or for an assessment of patent laws in general.

TECHNOLOGICAL PRIZES

In a prescient publication, in 1862 Samuel Sidney posed the question "Whether … manufacturing inventions [can be] stimulated, by invitations to compete for substantial or honorary awards?"[73] He rejected the purely theoretical approach others had adopted, and spent ten years investigating the data on

[72] The government ultimately contributed $2000, and rejected the request for an appropriation of $35,000. Only 95 of the U.S. exhibitors arrived in time for judging, but all of the displays of machinery and implements won prizes. See Benjamin Pierce Johnson, Report on International Exhibition of Industry and Art, London, 1862, Albany, NY (1863).

[73] Samuel Sidney, "On the Effect of Prizes on Manufacturers," Journal of the Society of Arts, Vol. 10 (April) 1862: 374-382. Sidney was trained as a lawyer, and was also an Assistant Commissioner of the Crystal Palace Exhibition in London in 1851.

prizes at international exhibitions and various societies for encouraging industry. His conclusions were that prizes tended to be inefficient, and improvements in market demand and competition offered the most effective inducements for inventive activity.[74] The prize system, he stated, merely encouraged "a long list of machines which, for practical purposes, are no better than toys" (p. 376). The market value of useful inventions was far greater than any prize that could be offered, whether by private or state initiative. Even specialized institutions such as the Royal Agricultural Society and the prestigious Royal Society of Arts had failed to develop truly significant inventions.[75] Moreover, the competitor for the prize had an incentive to over-spend on the item in an attempt to win, regardless of whether such investments were practicable in the marketplace. As a result, winners tended to be among the wealthiest of the competitors: "The theory that prizes encourage humble merit is only a theory, for experience shows that in a series of yearly contests wealth wins, as it must when hundreds of pounds must be expended to win ten" (376). However, from the perspective of manufacturers or retailers, prizes served as a useful marketing strategy, comparable to advertisements and enhanced brand name capital.

The preponderance of empirical evidence from my studies of Britain and the United States supports Sidney's first-hand experience and insights. More systematic insights into the relationship between incentives and innovation can be gleaned from a large sample of British and American inventors who were responsible for the great inventions of the period before the Second World War.[76] The inventors in the British sample were typically drawn from elite or professional backgrounds, and tended to be socially well-connected, even though productivity at invention was unrelated to such factors. The

[74] Sidney's conclusions are supported by the quantitative analysis of national and international prize systems discussed here. Administrative attempts to replicate the role of the market confronted significant obstacles. Judges had to combine technical competence and industry-specific knowledge with impartiality; decision-making among panels was complicated by differences in standards, interpretation, sometimes language barriers. The necessary tests of the items displayed was complicated by lack of comparability, poor information on marketability and price, and variations in taste. The most novel items were associated with the greatest risk, and therefore less likely to be selected. Such difficulties tended to lead to haphazard decisions, or were often overcome by simply making the award to the person or firm with the most established reputation.

[75] For a more positive assessment of the effectiveness of the Royal Agricultural Society, see Liam Brunt, Josh Lerner, and Tom Nicholas, "Inducement prizes and innovation." The Journal of Industrial Economics, 60.4 (2012): 657-696.

[76] B. Zorina Khan, "Premium Inventions: Patents and Prizes as Incentive Mechanisms in Britain and the United States, 1750-1930" in Dora L. Costa and Naomi R. Lamoreaux (eds), Understanding Long-Run Economic Growth: Geography, Institutions, and the Knowledge Economy, NBER and University of Chicago (2011): 205-234.

sample includes information on about 25 percent of the patents, along with the medals, monetary awards and other forms of official recognition that were granted to the 40 percent or so of these great inventors. As might be expected from the status of these inventors, the majority of their honours consisted of ex post awards, rather than "inducement" or ex ante prizes. Statistical analysis of the determinants of the probability that an inventor would receive a prize shows that patentees were more likely to get prizes, so the incremental incentive effects of an additional prize were likely quite low.

Many contemporary experts attributed the grant of financial awards, medals and prestigious appointments to nepotism, bias and even corruption. The data show that their views were not prejudiced, for prizes to British great inventors indeed owed to personal connections rather than to factors that were associated with the technical value of the discovery. The most significant variable affecting the award of a prize was an elite or Oxbridge education, which doubled the likelihood of such winning recognition. At the same time, specialized education or employment in science or technology, which might be expected to increase inventiveness, had little effect on the probability of getting a prize. The proponents of prizes today tend to cite the Longitude Prize (a monetary award for a method of gauging longitude at sea) to support their arguments, but it is ironic that a closer examination of the experience of the humble artisan John Harrison with the Board of Longitude would better serve as a caution against administered incentive systems.[77] The growing disillusionment in Europe with prizes as an incentive mechanism for generating innovation became evident when the Royal Society of Arts acknowledged the lack of social value in this practice.[78]

In the United States prizes for industrial purposes were not as prevalent as in Europe and, indeed, the most prominent of these awards were introduced in the United States at the instigation of foreigners. However, private and state promoters sponsored fairs in most large cities in the United States, on a

[77] Dava Sobel offers an account of Harrison's travails before the Board that was set up to administer the prize, in Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time, HarperCollins (2007).

[78] See the Royal Society of Arts, Year-book of the Royal Society of London, Issue 5, 1901: London (1901), p. 4. The RSA decided not to accept further funds for new prizes, because they had "been led by experience to the conclusion that it is neither to the advantage of the Society nor in the interests of the advancement of Natural Knowledge…"

regular basis, and these can be used to construct a panel data set of innovations that were submitted for industrial prizes. The sample of U.S. prizes comprises some 20,000 innovations from major cities, including Boston, New York, Philadelphia, San Francisco, Cincinnati, St. Louis, Atlanta and New Orleans.[79] These observations were matched with the patent records to identify the inventions that were patented. The information has further been linked with the manuscript population censuses, which yields insights regarding the backgrounds of individual inventors, such as occupations, age, wealth and geographical mobility.

The stated objective of industrial fairs was to advance the standing of innovative workers and artisans. Nevertheless, participants in the fairs were drawn from more prominent occupations than the general population of patentees. However, occupational class does not directly translate into financial standing. For this, we turn to the records on wealth-holding in the federal population censuses, which allows us to more directly assess the economic status of exhibitors relative to patentees in general. As Sidney had argued, the data reveal that the participants in the exhibitions were substantially wealthier than the general population. For instance, in 1860 the sample from the industrial fairs owned average personal property that was almost twice as extensive as that of patentees in general, and more than double their average real estate holdings. In multivariate regressions, exhibitors with greater personal wealth were more significantly more likely to win gold and silver medals. However, the mechanism through which wealthier exhibitors gained an edge over their competition is unclear. This finding was not due to their superior entries, but may have been associated with greater expenditures on their presentation at the fairs, or their name recognition, or perhaps to less obvious connections with the award juries. In general, the results support the argument that the majority of medals reflected factors other than inventiveness, productivity or technological innovation.

Patents in the United States are granted because they satisfy the specific rules and standards in federal laws; interpretations may vary among Patent Office examiners, but applicants have a right of

[79] For a description of a subsample of these data, see B. Zorina Khan, "Going for Gold: Industrial Fairs and Innovation in the Nineteenth-Century United States," Special Issue on Innovation without Patents, Revue Economique, vol. 64 (1) 2013: 89-114.

appeal that reduces error. The judges for industrial fairs may have stated that their objective was to reward novelty and inventive ingenuity. In practice, as was typically the case in Europe and in international exhibitions, they bestowed medals for an array of other reasons besides inventiveness, including overcoming adversity (such as age or physical handicaps), cheapness of the item, neatness, and aesthethic factors. The decentralization of judging committees, the lack of transparency and private nature of their decision-making process, and the absence of appeal from their rulings, all encouraged idiosyncratic and inconsistent decisions. Statistical analysis consistently indicates that almost all of the variation in the silver or gold awards also remains unexplained, implying that these grants were based on fairly random rationales. It is therefore not surprising that observers continually criticized the arbitrary way in which the awards were given out, at domestic and international fairs alike. A lack of systematic methods of allocating awards was likely to encourage rent-seeking, and to reduce the incentives for inventors who realized that prizes in many instances were uncorrelated with inventive merit.

Another perspective on such questions relates to the extent to which patents and prizes generate spillovers that affect other inventors or society in general. Ex ante, it is not clear which incentive mechanism which would benefit other inventors more. The majority of economists who support prizes focus on the right to exclude, and emphasize that prizes do not offer legal monopoly on ideas and are therefore more likely to promote diffusion. However, spatial autocorrelation analysis of patents and prizes reveals that patents significantly increased inventive activity in adjacent counties, whereas the patterns for prizes were inconsistent with the presence of technological spillovers. Thus, trade secrecy or even open access to ideas did not generate as much measurable benefit as in the case of inventions that were protected by patent grants.[80] Exhibitions sponsored by the Franklin Institute or the Cincinnati Mechanics' Association might have been open to the public, and some inventors might have been able to copy from the displays, but there was likely a selection effect that influenced the owners of inventions that were readily duplicable to avoid displaying them at fairs. Moreover, even if inventors had access to

[80] B. Zorina Khan, "Of Time and Space: A Spatial Analysis of Knowledge Spillovers among Patented and Unpatented Innovations," Working Paper (2013).

inventions at fairs, if they did not physically attend the events there were few or no ways to obtain the necessary information. This was of course a function of the decentralized nature of the prize system in the United States, but even in European countries that offered centralized institutions such as the Royal Society of Arts, access to unpatented inventions and knowledge about them was quite limited.

As a nineteenth-century commentator observed, "the assertion that the patent-system interferes injuriously with intellectual progress by blocking the course of thought is curiously at variance with the evidence of history."[81] The bargain or contract view of patents proposed that the limited grant of a monopoly right to inventors benefits society, because in exchange the public gained information about the discovery that increases social welfare. The patent grant required a specification that was sufficiently detailed to enable a person who is skilled in the arts to recreate the patented invention. From the earliest years of the patent system, American policy makers engaged in discussions about how to ensure that information was available to the broader public. Patent legislation included measures to publish information about patents that were granted in annual reports that were widely disseminated, and expired patents were published in newspapers. The U.S. Patent Office maintained local depositories and offices throughout the country. Thus, even if the patentee had acquired a monopoly for (at that time) fourteen to seventeen years, access to the information about the discovery may have facilitated inventions that worked around the initial patent, or led to ideas for follow-on inventions, as the rapid increase in patent applications and interferences illustrate. Prize systems may have functioned well in some specific instances, but in general tended to be arbitrary, unsystematic, and nonmarket-oriented. Thus, the founders of American technology policies seem to have been particularly prescient when they rejected "premiums" and instead opted for patent institutions to "promote the progress of science and useful arts."

CONCLUSION

History matters. This paper provides a comparison of institutions as well as patterns in patenting and those of innovation prizes during the "long nineteenth century." The results comport with the views of

[81] James Richardson, "Our Patent System and What We Owe to It," The Century Magazine, November 1878: 99-110, p. 103.

contemporary experts who had first-hand experience of the advantages and disadvantages of these institutions. Perhaps the most telling way to distinguish between competing claims is to understand why patent laws spread, with many countries voluntarily adopting the distinctinve U.S. rules and standards, whereas the majority of institutions that had consistently offered prizes for industrial innovations ultimately became disillusioned and the practice waned apart from a few special cases. Both nations and individuals were convinced that intellectual property grants played a prominent part in explaining why United States overtook other nations and became the world leaders in technology and industry.

Intellectual property institutions were successful in the United States largely because they ensured open access to creative individuals, decentralized decision-making and extensive markets for technology, and strong legal enforcement of such rights. Americans were enthusiastic about the patent system, although the same individuals were often critical of the administration of specific rules and standards. As such, it is useful to distinguish between the fundamental principles of these property rights, and the ways in which the laws are implemented. Many have rightly pointed out that current practices we observe in the use and enforcement of patent grants add to the transactions costs of inventive activity and markets in inventions. However, when taken in long-run perspective, today's "patent wars" and "explosion in litigation" are hardly anomalous or cause for dramatic revisions in the rules. New innovations and industries have always been associated with extreme competition and upsurges in costly litigation, that were resolved through private compromises.

A major difference with policy today is that, in the nineteenth century, the vast majority of the flurry of bills and proposals that appeared with every new circumstance never resulted in new legislation. Institutions must adjust to the times, but efficient changes need to be consistent with the underlying principles of the system. The transformative period up to the end of the Civil War produced no more than three major reforms in patent laws.[82] However, numerous new measures have been adopted in the past 75 years to confront short-run crises. These changes respond to the ephemeral demands of the most strident interest groups at a single point in time, many are introduced to remedy the negative

[82] These early reforms are reflected in the statutes of 1793, 1836 and 1861.

consequences of the last change, and not a few are inconsistent with the fundamentals of the U.S. system of intellectual property.[83] It is worth noting that market exchange is most effective when trades are independent of the identities of the parties involved, and remedies that adjust the validity or strength of property rights in patents based on the nature of the owner of those rights (whether they comprise a "non-practicing entity or practicing entity") undermine a basic principle of economic efficiency. Such inefficient changes in legal rules and standards will create incentives for corresponding changes in business policies that are most likely to result in the potential misallocation of resources.[84]

Those who advocate the introduction of new legislation justify the call for remedial measures by contending that the problems they discuss are largely of recent origin and threaten industrial progress or national competitiveness. This historical amnesia has resulted in a resurgence of interest in innovation prizes, based on the theoretical belief that they will generate innovations and entrepreneurship, in vastly different geographic, economic, and industrial circumstances. For instance, the Innovation Prize for Africa offers entrepreneurs cash prizes for such ideas as the use of fly larvae to produce animal feed.[85] In Israel, a one-million dollar "B.R.A.I.N. prize" was introduced in an effort to transform the country into a leader in such technology.[86] At the same time, the historical record shows that administered prize systems were associated with the potential for bias or corruption, unpredictable methods of allocation and outcomes, as well as other deficiencies attendant on a nonmarket orientation. These issues are all the more likely to be problematic in developing countries, where complementary institutions and governance mechanisms are typically flawed. Such observations do not imply that inducement or reward prizes are

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[83] For instance, the extension of the term of copyright has resulted in a virtually perpetual grant; and the adoption of the first to file criterion has biased the nature of the patent system towards corporations rather than awards for independent creativity.

[84] If courts were to offer more protection to producers or patentees, as opposed to intermediaries, the discriminatory treatment in effect would subsidize producers and tax nonproducers, which would create distortions. The latter would have an incentive to make nominal investments in production facilities or to hire patentees as a bar to such charges, or to engage in further unproductive defenses that would circumvent the rules at some private and social cost.

[85] http://innovationprizeforafrica.org/ .

[86] The goals of Israel Brain Technologies (http://israelbrain.org/) include "positioning Israel as a global brain-tech hub" and taking it "from startup nation to brain nation." The B.R.A.I.N. Prize (Breakthrough Research And Innovation in Neurotechnology) will reward "extraordinary breakthroughs in brain technology with global implications" and "recognize a disruptive innovation that is on a path to commercialization with potential significant impact to humanity."

never effective in generating technological innovations, for they can prove to be useful in certain specific circumstances, such as in the event of market failure that prevents innovators from appropriating benefits. They may further serve to elicit the attainment of unique and well-specified targets, as long as the difficulties of decision-making and governance issues are explicitly recognized and addressed. The point is that technology policies, whether in the developed nations, or in emerging economies, are unlikely to be effective unless all the costs and benefits of alternative options are fully taken into account. Significantly more research needs to be completed before we can conclude that such awards should be re-introduced in the twenty-first century as a means of promoting entrepreneurship and technological progress. As Brander Matthews points out in the epigraph, successful policies to promote the progress of science and the useful arts must be consistent with the underlying trend of legal and economic development.

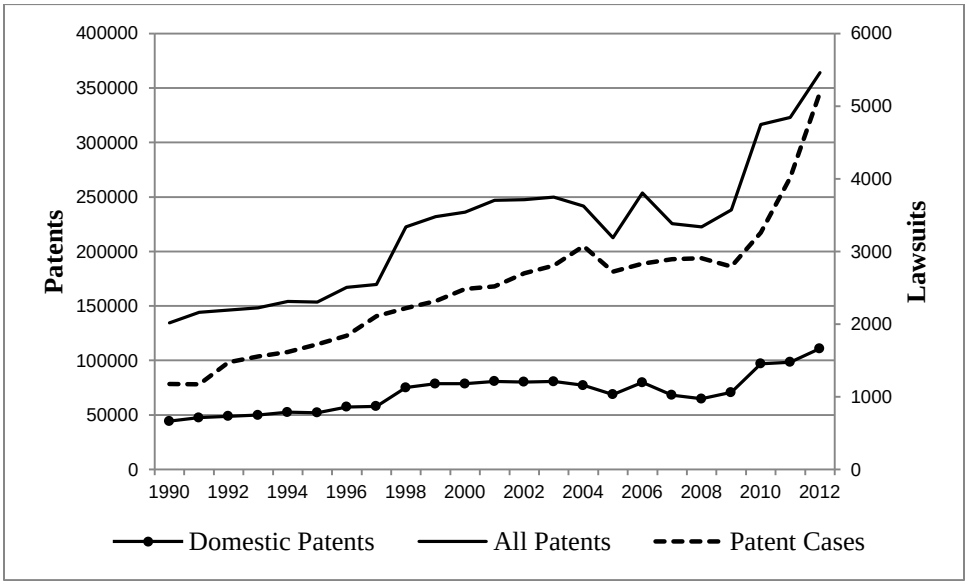
TABLE 1
U.S. 'GREAT INVENTOR' PATENTS
LEVEL OF EDUCATION AND APPROPRIATION OF RETURNS
BY BIRTH COHORTS, 1739-1885

	Level of Education				
Birth Cohort	Primary	Secondary	College	Eng/NatSci.	n
1739-1794 (row %)	69.5	6.8	12.5	11.3	40
sell/license (%)	54.9	11.1	84.0	17.7	51.4
prop/direct (%)	36.5	74.1	2.0	44.7	35.6
employee (%)	6.2	7.4	--	--	4.8
1795-1819 (row %)	59.1	19.3	5.4	16.2	7
sell/license (%)	58.2	81.0	42.1	60.4	62.1
prop/direct (%)	33.2	10.2	47.4	24.3	28.1
employee (%)	8.4	8.8	--	13.5	8.8
1820-1845 (row %)	39.2	34.7	16.3	9.7	1221
sell/license (%)	50.7	31.8	37.4	72.8	44.0
prop/direct (%)	42.3	55.2	47.7	19.3	45.5
employee (%)	7.7	13.0	14.9	7.0	10.2
1846-1865 (row %)	22.2	24.5	20.9	32.4	1438
sell/license (%)	94.5	68.5	46.2	57.1	66.0
prop/direct (%)	5.5	18.6	52.8	16.9	22.6
employee (%)	--	12.9	--	23.6	10.4
1866-1885 (row %)	0.2	17.9	21.4	60.5	574
sell/license (%)	--	1.0	46.3	40.1	34.3
prop/direct (%)	100.0	98.1	49.6	18.7	39.7
employee (%)	--	1.0	4.1	41.2	26.0

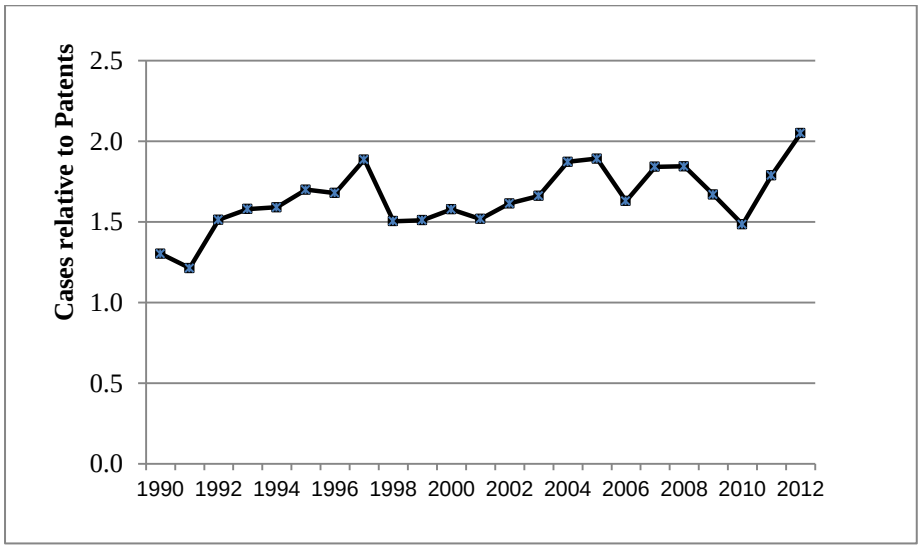
Notes and Sources: The estimates have been computed over 4325 patents awarded to the 409 'great inventors' who were born through 1885. For further information, see Khan, B. Zorina and Kenneth L. Sokoloff, "Institutions and Technological Innovation During Early Economic Growth: Evidence from the Great Inventors of the United States, 1790-1930," in Institutions and Economic Growth, (eds) Theo Eicher and Cecilia Garcia-Penalosa, MIT Press (2006):123-158.

Figure 1
Patent Litigation, relative to Total and Domestic Patent Grants
(1990-2012)

(a) Cases and Patents

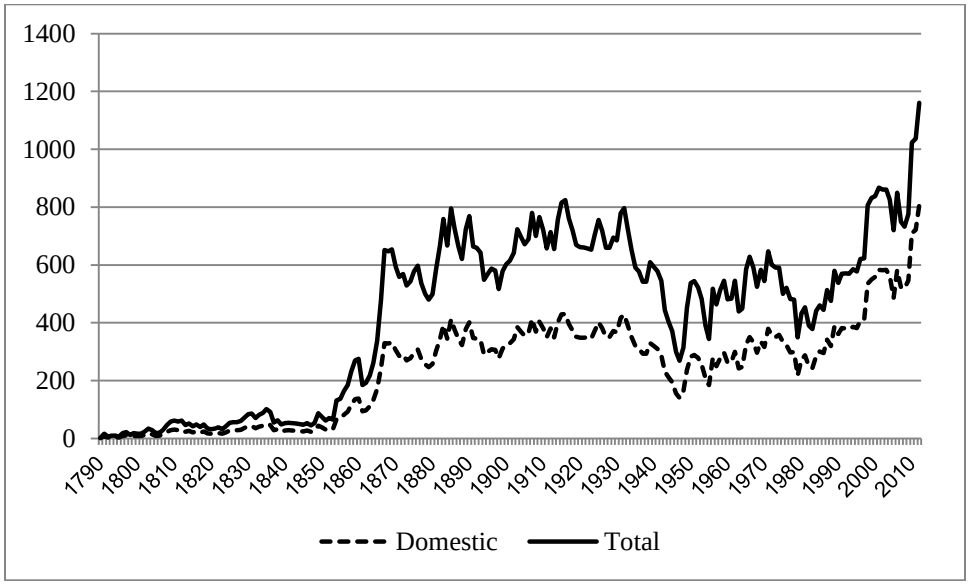


(b) Litigation rate (percentage)



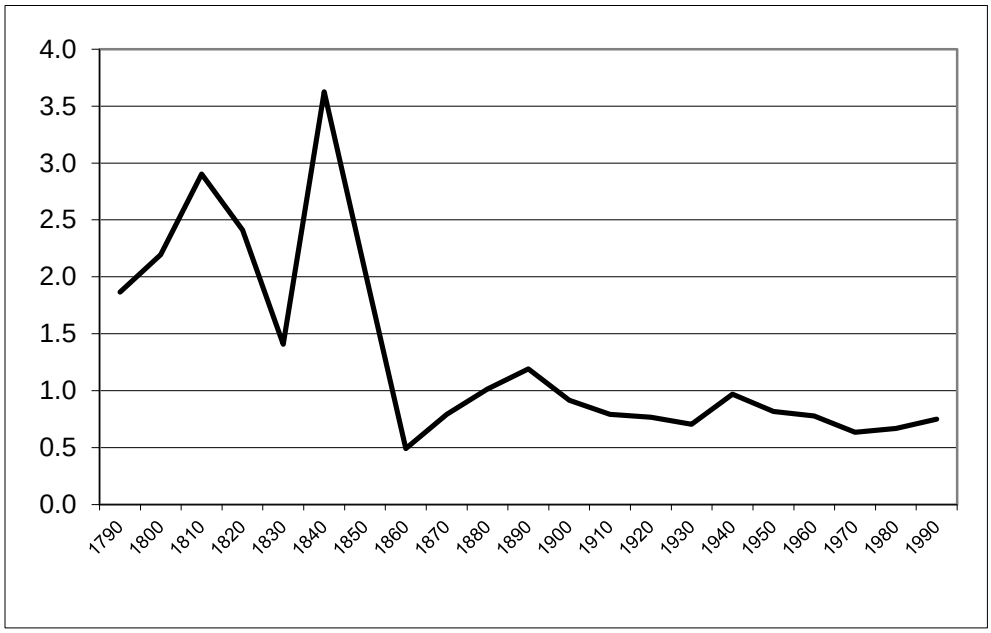
Notes and Sources: Patent cases were retrieved from Annual Reports of the Director: Judicial Business of the United States Courts (various years); Patent grants were reported by the USPTO.

Figure 2
U.S. Patenting Rates: Grants Relative to Population, 1790-2012



Notes and Sources: Patent grants data are from the Annual Reports of the U.S. Patent Office, and population data are from the U.S. Census Bureau. Patents are calculated per million of the population.

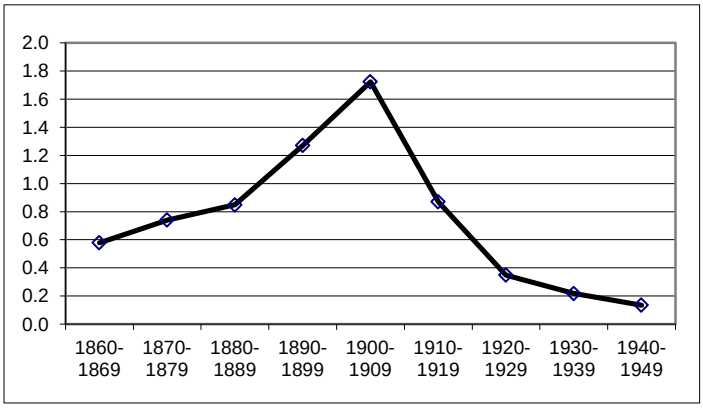
Figure 3
Patent Litigation Rates, 1790-2000
(Reported Lawsuits as a Percentage of Total Patents granted, by Decade)



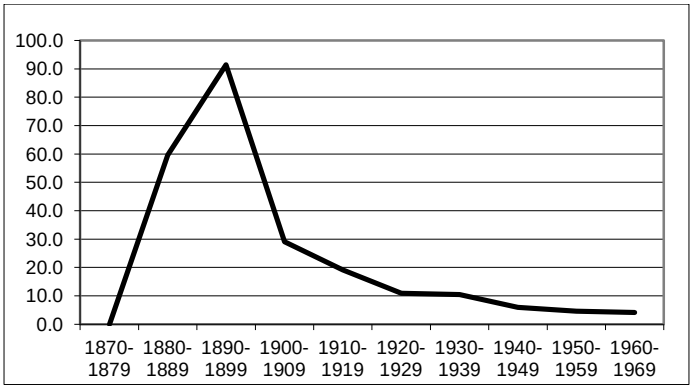
Notes and Sources: Patent lawsuits were estimated from Lexis and from volumes of reports of patent cases. Patent grants were obtained from annual reports of the U.S. Patent Office.

Figure 4
Total Litigation Relative to Usage for Major Innovations (Percentages)

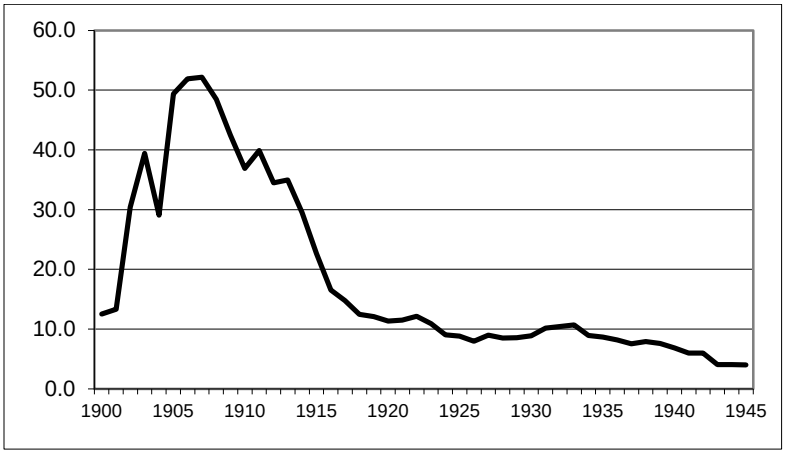
(a) Telegraph, 1860-1950



(b) Telephones, 1870-1970



(c) Automobiles, 1900-1945



Notes and Sources: The counts of federal and state lawsuits related to the innovations were estimated from the Lexis database. Usage data are included in United States, Bureau of the Census, Historical Statistics of the United States, Washington, DC: GPO (1975). The telegraph usage is measured by millions of messages sent (series R46-70); telephone usage by average daily conversations in thousands (series R1-12); and automobiles by registrations (series Q1-53).