HOOVER IP²

WORKING PAPER SERIES
NO. 16004

PATENTS AND THE WEALTH OF NATIONS

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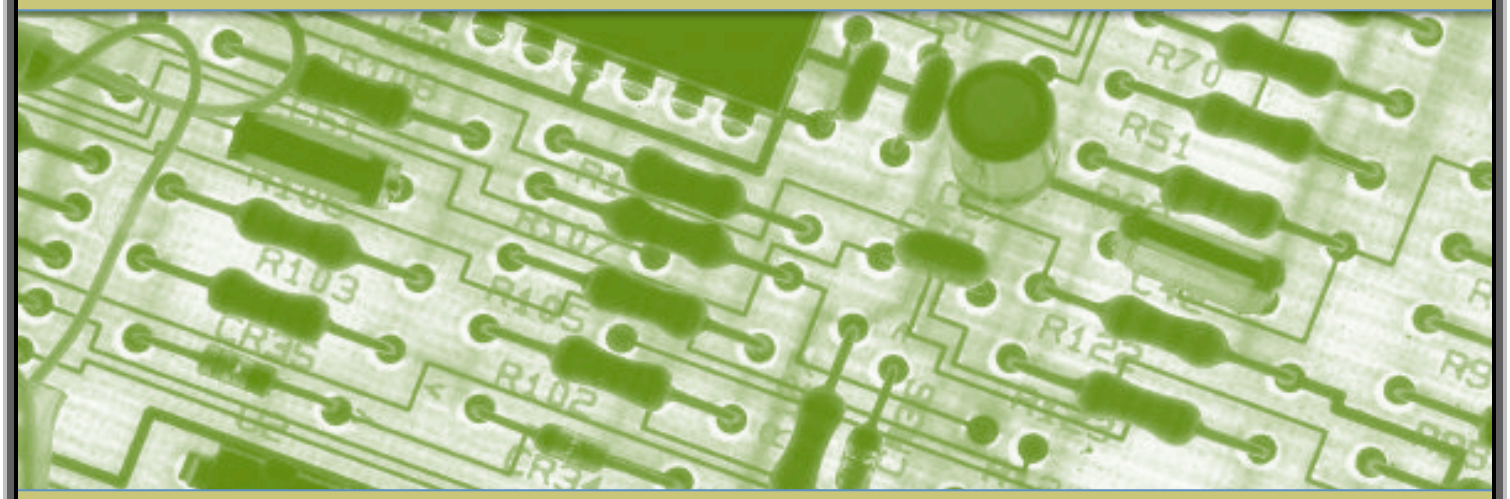
REVISED: JUNE 5, 2016
ORIGINAL: JANUARY 26, 2016



Hoover Institution Working Group on
Intellectual Property, Innovation, and Prosperity
Stanford University

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PATENTS AND THE WEALTH OF NATIONS

Stephen Haber [*] [**]

INTRODUCTION

There is abundant evidence from economics and history that the world's wealthy countries grew rich because they had well-developed systems of private property. Clearly defined and impartially enforced property rights were crucial to economic development; they facilitated trade, trade allowed individuals and business enterprises to specialize, specialization made individuals and business enterprises more productive, and more productive firms and individuals in the aggregate raised national income. Innovation and economic growth, in short, emerged out of property systems that allowed economies to operate as a web of contracts. The origin of these ideas go back to Adam Smith's *The Wealth of Nations*, but they were subsequently elaborated upon by Douglass C. North in 1981, Daron Acemoglu and James A. Robinson in 2012, and other scholars who made explicit the connection between property rights and the incentives to transact.[1]

We cannot stress strongly enough the point: economic wellbeing is an outcome of specialization, and specialization is an outcome of private property rights. Take away clearly defined and impartially enforced property rights and the web of contracts that permits specialization breaks down, so that there is little or no economic surplus created by people trading with one another. Would you build an addition to your house if somebody else could move in without your permission? But if you do not build the addition,

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[**] This paper benefited from helpful comments by Jonathan Barnett, Alexander Galetovic, Scott Kieff, Gary Lauder, Ross Levine, Victor Menaldo, Paul Sniderman, Richard Sousa, William Summerhill, and Seth Werfel. Jordan Horrillo provided invaluable research assistance.

[1] *See generally* DARON ACEMOGLU & JAMES A. ROBINSON, WHY NATIONS FAIL: THE ORIGINS OF POWER, PROSPERITY, AND POVERTY (2012); DOUGLASS C. NORTH, STRUCTURE AND CHANGE IN ECONOMIC HISTORY (1981); ADAM SMITH, THE WEALTH OF NATIONS (Edwin Cannan ed., Random House, Inc. 1994) (1776).

there is no contract with a builder, and if there is no contract with a builder, there are no subcontracts with architects, plumbers, electricians, carpenters, and roofers. Now imagine your problem scaled up to an entire society: the absence of property rights not only means that there will be many fewer contracts and subcontracts, the absence of contracts means that there will not be anywhere near the same incentives for anyone to specialize in general contracting, architecture, plumbing, electricity, carpentry, and roofing in the first place. In this imaginary world, you will still need a place to live—but you will construct that abode yourself—because other people lack the incentives to be any better at those skills than you are, and there is no incentive for you to construct anything but a very modest dwelling—lest you give someone else an incentive to move in without your permission! Now imagine that this problem of weak property rights is not confined to real property, but permeates the rights to just about anything that can be owned—both tangible and intangible. In equilibrium, no one will specialize in anything; everyone will be an inefficient jack-of-all-trades. The level of economic development in your society will be stunningly low. It would be nice if this were a parable. Sad to say, it describes much of the developing world.

These ideas are not in dispute; they have been tested again and again, across multiple subfields of economics—but that presents us with a puzzle. If both reason and evidence point to the crucial role played by property rights in the wealth of nations, then how can some scholars hold that strong rights to intellectual property ("IP") are hindering innovation and holding back economic growth?[2] Should not the same logic hold for IP as for any other kind of property?

The key to the idea that IP—and patent rights, in particular—are somehow different from other property rights resides in a fundamental misperception, misunderstanding, or misrepresentation of a patent. It is not, as some IP critics maintain, a grant of monopoly. Rather, it is a temporary property right to something that did not exist before that can be sold, licensed, or traded.[3]

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[2] *See* JAMES BESSEN & MICHAEL J. MEURER, PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATORS AT RISK 5 (2008) ("Overall, the performance of the [U.S] patent system has rapidly deteriorated in recent years. By the late 1990s, the costs that patents imposed on public firms outweighed the benefits. This provides clear empirical evidence that the patent system is broken. . . . [O]ur analysis has relevance to innovation in other countries."); Michele Boldrin & David K. Levine, *The Case Against Patents*, 27 J. ECON. PERSP. 3, 3 (2013) ("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."). *See generally* MICHELE BOLDRIN & DAVID K. LEVINE, AGAINST INTELLECTUAL MONOPOLY (2008); ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS: HOW OUR BROKEN PATENT SYSTEM IS ENDANGERING INNOVATION AND PROGRESS, AND WHAT TO DO ABOUT IT (2004).

[3] Adam Mossoff, *Patents as Constitutional Private Property: The Historical Protection of Patents Under the Takings Clause*, 87 B.U. L. REV. 689, 693 (2007) ("It is beyond cavil that patents are

A patent can only confer a monopoly in production if there are *absolutely* no substitutes for a patented technology, the technology is itself being sold legally by the owner or her affiliates, and the patent owner declines to sell licenses. Put differently, a patent is only a right to exclude, not use, and a host of other property rights and regulatory regimes often limit the ability of a patentee to actually sell a patented product or service into a wide enough market to trigger our antitrust or anti-monopoly sensibilities. Moreover, any particular patented product or service may, and often does, compete with many substitutes in the market. Consider the market for over-the-counter pain medications in the United States, most of which have been patented: there is vibrant competition among aspirin, acetaminophen, ibuprofen, and other active ingredients.

The fact that there are almost always substitutes explains why there often is no market power conveyed by a patent even in cases where there are many patented technologies needed to sell one larger product, such as a personal computer, a cell phone, an automobile, or a running shoe.[4] One may have a patent on the manner in which the fuel injection system measures the mix of air and gasoline in the car he builds, but a car that measures the mix of air and gasoline in a different manner will not infringe that patent. Precisely because it is almost always possible to invent around a patent, patentees have an incentive to sell others a license to their patent. Patentees can either get a royalty equal to some percentage of output, or they can get zero; others have the choice between paying a royalty equal to some percentage of their output or bearing the costs of inventing around a patent. Writing a contract to license the patent therefore makes both parties better off. In fact, if someone actually had a technology for which there were no substitutes and which could not be reverse engineered by a third party at a lower cost than the research and development ("R&D") and other costs already incurred by the inventor, he would not patent it at all![5] He would instead take advantage of his proprietary knowledge to dominate the market. The result *would be* a monopoly—but it would have nothing to do with patents.

The fact that patents are property rights means that they can serve as the basis for the web of contracts that permits individuals and firms to specialize in what they do best. This includes designing a better way to meas-

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property rights, and currently there is a vibrant debate among scholars and jurists as to whether the recent expansion in these property rights is unprecedented, unjustified, or both." (footnote omitted)).

[4] This is supported by the low rates at which patents are renewed, which is consistent with other indicators suggesting extreme skew in the commercial value of patents. *See* F.M. Scherer & Dietmar Harhoff, *Technology Policy for a World of Skew-Distributed Outcomes*, 29 RES. POL'Y 559 (2000); F.M. Scherer et al., *Uncertainty and the Size Distribution of Rewards from Innovation*, 10 J. EVOLUTIONARY ECON. 175 (2000).

[5] *See* Jonathan M. Barnett, *Is Intellectual Property Trivial?,*157 U. PA. L. REV. 1691 (2009) (discussing the conditions under which a firm might prefer to appropriate the returns from innovation via mechanisms other than patents).

ure the air-gasoline mixture in a fuel injection system, writing a patent application for that design, negotiating a contract to license the patent to a manufacturer, manufacturing the measuring device, assembling the injection system, installing the system in an engine, or writing a debt contract collateralized by the injectors, the engine, or the accounts receivables for the patent so that the parties in the production chain can obtain working capital. Take away the property right for the new way to measure air and fuel, and the whole system falls apart.[6]

This Essay offers a thoughtful way to consider the aggregate social value of this property right by examining the evidence from economic history and cross-country econometric scholarship in order to assess the claim of some academics and policymakers that strong patent rights are more likely to blunt than encourage economic growth. Part I of this Essay frames our discussion by suggesting we adopt a social scientist's skepticism when evaluating claims about causality. Part II therefore focuses on what we can learn about the causal relationship between patent systems and economic growth by exploiting the dimension of time. It examines the economic history of the British patent system during the Industrial Revolution and the phenomenal growth story of the United States, whose constitutionally required patent system found enthusiastic support in the early U.S. judiciary. Part III surveys an array of studies employing econometric methods in an attempt to discern causal relationships between patent strength and economic growth—while maintaining a cautious awareness of the limits of these studies. Even with a healthy dose of academic skepticism, however, Part III concludes that the weight of the evidence supports the claim of a positive causal relationship between the strength of patent rights and innovation—and thus, economic growth. Part IV asks how this information translates to the twenty-first-century U.S. economy and argues that this causal relationship is still highly relevant.

I. HOW WOULD I KNOW IF I AM WRONG?

One of the core principles of the social sciences is that scholars are expected to be actively skeptical about their own claims. The gold standard is the ability to answer the crucial question "how would I know if I am wrong" and demonstrate that the weight of the evidence does not support

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[6] *See generally* Stephen H. Haber et al., *On the Importance to Economic Success of Property Rights in Finance and Innovation*, 26 WASH. U. J.L. & POL'Y 215 (2008); F. Scott Kieff, *Coordination, Property, and Intellectual Property: An Unconventional Approach to Anticompetitive Effects and Downstream Access*, 56 EMORY L.J. 327 (2006); Henry E. Smith, *Intellectual Property as Property: Delineating Entitlements in Information*, 116 YALE L.J. 1742 (2007); Daniel F. Spulber, *How Do Competitive Pressures Affect Incentives to Innovate When There Is a Market for Inventions?*, 121 J. POL. ECON. 1007 (2013); Daniel F. Spulber, *How Patents Provide the Foundation of the Market for Inventions,* 11 J. COMPETITION L. & ECON. 271 (2015).

the hypothesis that the scholar is wrong. That is, researchers have a positive duty to test their claims against the null hypothesis, and present all the evidence, including that consistent with the null.

A skeptic would ask what evidence indicates that there is, in fact, a relationship between the strength of patent rights and the wealth of nations. A first step in providing an answer would be to see if there is a cross-sectional relationship between the strength of enforceable patent rights and levels of economic development across countries by making a simple two-way scattergram. As discussed in detail below, such a graph would not be a dispositive test of a causal relationship—one must be mindful of reverse causality and omitted variables—but the absence of a discernible pattern in cross-section would suggest that more finely tuned analyses would be unlikely to yield much in the way of results. Figure 1 therefore presents a graph of the strength of enforceable patent rights and levels of economic development for all non-petro states in 2010.[7] There is nothing ambiguous about the resulting pattern: there are no wealthy countries with weak patent rights, and there are no poor countries with strong patent rights. Indeed, Figure 1 shows a remarkably tight pattern: as patent rights increase, GDP per capita increases with it. Roughly speaking, for every one-unit increase in patent rights (measured from zero to fifty) per capita income increases by $780. A simple regression of patent rights and patent rights squared on GDP indicates that roughly three-quarters of the cross-sectional variance in per capita GDP around the world is explained by the strength of patent rights.[8]

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[7] Per capita GDP is from Penn World Tables version 8.1, output series. The index of enforceable patent rights is constructed following Albert G.Z. Hu & I.P.L. Png, *Patent Rights and Economic Growth: Evidence from Cross-Country Panels of Manufacturing Industries*, 65 OXFORD ECON. PAPERS 675 (2013), and Jihong Zhang et al., *How Private Property Protection Influences the Impact of Intellectual Property Rights on Economic Growth?*, 44 GLOBAL ECON. REV. 1 (2015), by multiplying the Ginarte-Park Patent Strength Index by the Fraser Institute index of the quality of legal systems and property rights. For the Ginarte-Park Index, see Juan C. Ginarte & Walter G. Park, *Determinants of Patent Rights: A Cross National Study*, 26 RES. POL'Y 283 (1997), and Walter G. Park, *International Patent Protection: 1960–2005*, 37 RES. POL. 761 (2008). I thank Walter Park for providing me with the 2010 update. The Fraser Institute index of the quality of legal systems and property rights is a subcomponent of their larger Economic Freedom Around the World Report. *See* JAMES GWARTNEY ET AL., ECONOMIC FREEDOM OF THE WORLD: 2015 ANNUAL REPORT (2015). We exclude petro-states, defined as economies in which average petroleum revenues per capita from 1991 to 2014 exceed $1,000—and do so because the peculiar combination of a huge petroleum endowment and a small population size is an idiosyncratic and a non-replicable strategy of economic development. We note that the inclusion of these countries would not materially change the results. We speculate that this is the case because strong IP rights may explain the success that some countries—particularly, Canada and Norway—have had in finding and exploiting difficult-to-access petroleum deposits. For a discussion about the role of property rights in the discovery and exploitation of subsoil wealth, see Paul A. David & Gavin Wright, *Increasing Returns and the Genesis of American Resource Abundance*, 6 INDUS. & CORP. CHANGE 203 (1997).

[8] Following standard practice, the regression is run on the natural logs of patent rights, patent rights squared, and GDP. Patent rights and patent rights squared are both statistically significant at one

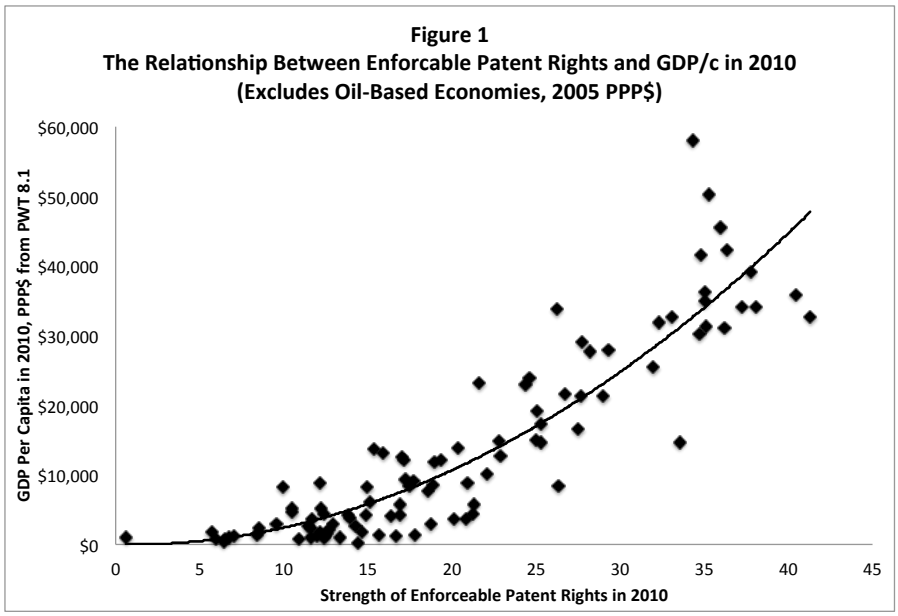

Figure 1 also suggests that there are non-linearities in the relationship between patent strength and per capita income: at high levels of per capita income, as patent rights increase, per capita income increases more than at low levels of per capita income. One easy way to see this is to look at how the observations cluster along a trend line that is drawn as a quadratic polynomial (per capita income is modeled as a function of patent rights and patent rights squared).

Some may also be skeptical that that causality runs from enforceable patent rights to GDP per capita, and not from GDP per capita to enforceable patent rights. Perhaps richer countries invest more in protecting intellectual property. Or, perhaps other factors that might be correlated with strong patent rights—such as openness to foreign trade and investment, the depth of the financial sector, or levels of education—are also important determinants of GDP per capita, but their effect is being spuriously attributed to patent rights because Figure 1 does not take account of them.

These are not just intellectual musings. The true causal relationship between patent strength and economic innovation is almost certainly smaller than that suggested by Figure 1. The question is by how much. Is the strength of patents of no importance, of moderate importance, or of crucial

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percent. If one excludes small countries, particularly Singapore and Luxembourg, the relationship becomes stronger still. Running the regression on absolute values of GDP and patent strength does not change the qualitative results. This is not to say, however, that the addition of controls for other factors that might influence the level of GDP per capita and might co-vary with patent strength would not weaken the observed relationship. This Essay pursues approaches to these issues of identification in Part III.

importance to determining a society's level of innovation and material wellbeing?

Two types of evidence allow us to gain traction on these questions about causality. The first is research by economic historians about the relationship between patent rights and economic development within countries over time, and the second is econometric analyses of cross-country datasets. Each approach to causality has its advantages and disadvantages; there is no one "right" approach or method. What is important, however, is whether the most careful methods—those that are best designed to answer the question under study given the constraints imposed by the nature of the evidence—applied in both approaches yield the same general conclusion.

II. LESSONS FROM ECONOMIC HISTORY

Economic historians have had much to say about the impact of patent laws on innovation. They have focused on two questions in particular that are relevant to gaining traction on the causal relationship between patent laws, rates of patenting, and rates of innovation. The first of these focuses on whether the British patent system facilitated or frustrated the Industrial Revolution. The second focuses on whether the U.S. patent system played a crucial role in the emergence of the United States as a high-income industrial economy.

Why did the Industrial Revolution take place in Britain, and not, say, in France or the Netherlands? Why was it a phenomenon of the last third of the eighteenth and first third of the nineteenth centuries, and not earlier, or later? One central part of the answer to these questions has focused on the role played by the British patent system. Did British inventors patent new industrial technologies? Did the patents include sufficient information such that they were useful vehicles for the transmission of technical knowledge to other inventors or implementers? Did courts enforce patents? Was there a market for invention such that inventors could appropriate the returns to their labors through licensing or assignment? Did the appropriation of those returns promote, rather than hinder, technical progress?

These questions about the British patent system have been extensively researched by historians, and while there are disagreements among them, all find that from at least the latter half of the eighteenth century, the patent system promoted the inventive activity associated with the Industrial Revolution; none suggest that the patent system frustrated innovation.[9] The most

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[9] *See* SEAN BOTTOMLEY, THE BRITISH PATENT SYSTEM DURING THE INDUSTRIAL REVOLUTION 1700-1852: FROM PRIVILEGE TO PROPERTY (2014); HAROLD IRVIN DUTTON, THE PATENT SYSTEM AND INVENTIVE ACTIVITY DURING THE INDUSTRIAL REVOLUTION, 1750-1852 (1984); CHRISTINE MACLEOD, INVENTING THE INDUSTRIAL REVOLUTION: THE ENGLISH PATENT SYSTEM, 1660-1800 (1988).

analytically clear and carefully researched study of the role of patents in the British Industrial Revolution is the recent book by Dr. Sean Bottomley.[10] His findings, based on the most complete archival research to date, can be summarized as follows. First, there is a difficult to miss relationship between a dramatic and sustained acceleration in the number of patents awarded and the onset and acceleration of industrialization in Britain during the period 1760-1850.[11] Second, until patent laws were passed in the United States and France in the 1790s, no other country had a functional patent system that inventors used on a regular basis.[12] Third, very few important inventors of the Industrial Revolution did not make use of the patent system, and they relied on the patent system because the lag time between the genesis of an idea and actual working model of an invention could be as long as a decade; unless there was a way to appropriate the returns from the invention, they could not have invested their time, energy, and capital in their creative endeavors.[13] Fourth, while the British patent system was characterized by administrative encumbrances and high fees, in the last quarter of the eighteenth century patent agents emerged who specialized in navigating administrative hurdles, while inventors formed partnerships and joint stock companies with entrepreneurs in order to mobilize capital to underwrite R&D costs, commercialize the invention, and pay whatever fees were required.[14] Fifth, there were numerous legal remedies that inventors could utilize against competitors who infringed their patents, including injunctions. From at least the last quarter of the eighteenth century onwards, patents were conceived as a property right and were treated as such by the judiciary.[15] Sixth, as of the 1730's, Britain's patent law required detailed specifications in order for a patent to be granted and legally defended against infringement, which meant that patents were important in the diffusion of new technologies.[16] Seventh, there was an active and lucrative market in patent rights, including direct sale to other parties, the granting of licenses in exchange for royalties, and the formation of joint stock companies that allowed inventors to exchange their patents for shares in companies that specialized in commercializing the patent.[17] It bears highlighting that many of the changes to Britain's patent laws and their enforcement—the requirement for detailed specifications, patents conceived as property

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10 *See* BOTTOMLEY, *supra* note 9.

11 *See id.* at 18.

12 *Id*.

13 *Id.* at 19, 20, 266.

14 *Id.* at 65-73, 172, 202-30, 266-83.

15 *Id.* at 95-142; *see also* Adam Mossoff, *Rethinking the Development of Patents: An Intellectual History, 1550-1800*, 52 HASTINGS L.J. 1255 (2001) (reaching the same conclusion about patents being conceived of as property rights in the United Kingdom beginning in the late eighteenth century).

16 *See* BOTTOMLEY, *supra* note 9, at 46-50, 157-61, 188-99.

17 *Id.* at 202-30.

rights, the emergence of patent agents—all preceded, rather than followed, the onset of industrialization.

Dr. Bottomley is careful to specify the chain of reasoning that supports his claims and the evidence that supports those reasons. He is also careful to test his claims against alternative reasons and alternative evidence. As part of those tests of robustness, he shows that the claims made by the widely cited study by Professors Boldrin and Levine about patents frustrating the British Industrial Revolution are inconsistent with the facts. For example, Boldrin and Levine claim that James Watt, who invented the crucial secondary condenser that increased the power of steam engines, and his business partner, Matthew Boulton, were uninterested in manufacturing steam engines themselves, and thus "few steam engines were built during the period of Watt's legal monopoly."[18] Instead, "their activity consisted primarily of extracting hefty monopolistic royalties. Independent contractors produced most of the parts, and Boulton and Watt merely oversaw the assembly of the components by the purchasers."[19] According to Boldrin and Levine, Boulton and Watt "use[d] the patent system as a legal cudgel with which to smash competition."[20] The net result was that the proliferation of steam engines was delayed until the Watt patents expired in 1800.[21]

Bottomley shows that the facts are not as Boldrin and Levine present them.[22] For starters, there had been no significant improvement to the basic design of Thomas Newcomen's steam engine of 1712 until 1765, when Watt began to work on his separate condenser.[23] Second, it took Watt four years to perfect his new design, during which time he and his business partners burnt through a small fortune on R&D.[24] Third, the claim that Boulton and Watt produced few steam engines during the period covered by their putative "monopoly" does not square with the fact that they manufactured 478 steam engines during the period covered by their patents.[25] This output accounted for roughly one-quarter of the steam engines produced, which

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18 *See* BOLDRIN & LEVINE, *supra* note 2, at 3.

19 *Id.* at 2.

20 *Id.*

21 *Id.* at 1-2.

22 *See* BOTTOMLEY, *supra* note 9, at 247-65; *see also* George Selgin & John L. Turner, *Strong Steam, Weak Patents, or the Myth of Watt's Innovation-Blocking Monopoly, Exploded*, 54 J.L. & ECON. 841 (2011) (arguing that Watt's patent may have even hastened the development of the high-pressure steam engine).

23 *See* BOTTOMLEY, *supra* note 9, at 247.

24 *See id.* at 248-49.

25 *See id.* at 250, 259 (addressing the claim that Boulton and Watt's subcontracting of engine parts is evidence of rent seeking—by pointing out that it was standard practice for eighteenth century engine makers to use subcontractors). Whether it was standard practice or not, Boldrin and Levine's claim is a red herring. Virtually every product manufactured in the world today, from t-shirts to automobiles, is produced using subcontractors.

was hardly a trivial number, but could not be termed a "monopoly" either.[26] Fourth, Boulton and Watt did not deploy their patent as a "legal cudgel" against their new competitor, Jonathan Hornblower, who patented an improvement on Watt's secondary condenser in 1781. They did not seek an injunction against Hornblower until 1799—eighteen years after Hornblower started producing his engine, and one year before their own patent expired.[27] Until that time, mine owners were free to use the Hornblower engine, provided that they paid a royalty to Boulton and Watt covering Watt's initial patent on a steam engine with a secondary condenser. Finally, the claim that the Watt patent held up the dissemination of steam power technology is belied by the fact that Boulton and Watt did not possess a monopoly on steam engines and by the fact that after the Watt patent expired in 1800 not a single Hornblower engine was erected.[28]

What would have happened in the absence of the British patent system? Would England and Scotland industrialized, and if so, how would that process of industrialization have been different? Obviously, historians cannot go back in time and do a randomized control trial—assigning a patent system to one part of Britain and no patent system to another. The work of economic historian Professor Petra Moser, however, allows us to do the next best thing.[29] Moser looks at the products exhibited at the World Exhibitions of the late nineteenth century and asks whether the presence or absence of patent systems across countries affected the types of industries that emerged. She finds that countries that either lacked patent systems entirely or that had weakly enforced patents tended to focus on a small set of industries that depended on technologies that could not be backward engineered, such as the manufacture of scientific instruments.[30] Those countries lagged Britain and the United States, the two countries with the strongest patent protection, in the development of a broader set of industries, such as machinery, whose technologies could be backward engineered, and thus required patents in order to flourish.[31] The implication is that had Great Britain not had a patent system, the growth of key industries, particularly those that required steam engines and mechanized production, would have been stunted.

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26 *See id.* at 259.

27 *Id.* at 260-61.

28 *See id.*

29 *See* Petra Moser, *How Do Patent Laws Influence Innovation? Evidence from Nineteenth-Century World Fairs*, 95 AM. ECON. REV. 1214 (2005).

30 *See id.* at 1216.

31 *See id.* at 1215-17; *see also* B. Zorina Khan, *Trolls and Other Patent Inventions: Economic History and the Patent Controversy in the Twenty-First Century*, 21 GEO. MASON L. REV. 825, 846 (2014) [hereinafter Khan, *Trolls and Other Patent Inventions*] (making the point that one of these patent-eschewing countries, Switzerland, later adopted a patent system (in 1888) modeled on that of the United States—doing so because Swiss manufacturers were concerned that they were rapidly falling behind their U.S. competitors in products that could be mass produced).

One of the major themes of British economic history is the shortcomings of its patent system as compared to that of the United States, which is universally regarded as providing the strongest patent protection at the lowest cost to inventors after the Patent Act of 1790.[32] This prompts the question: did the strong patent system created in the newly independent United States play a role in fomenting the rapid industrial development that took place afterwards? Three scholarly generations of economic historians have carefully pursued this question, and their answer is a unanimous yes.[33]

Before we turn to a discussion of the findings of the economic history literature, we might first pause to ask why the United States was the first country in the world to write a patent system into the Constitution, the only property right so enshrined, and then make it so easy to get a patent and difficult to infringe one. A good part of the answer is contained in Figure 2, which graphs real (inflation adjusted) GDP per capita for the United States, Great Britain, and Brazil from 1700 to 1913.[34] These figures should be taken with a grain of salt. Modern systems of national accounting were not developed until the 1950s[35]—everything before that is a reconstruction, and generally speaking, the farther back one goes the less reliable the data tend to be. Thus, the data points should be taken as statements of relative magnitude rather than as absolute values. That said, one does not have to squint to see the difference in relative magnitudes.

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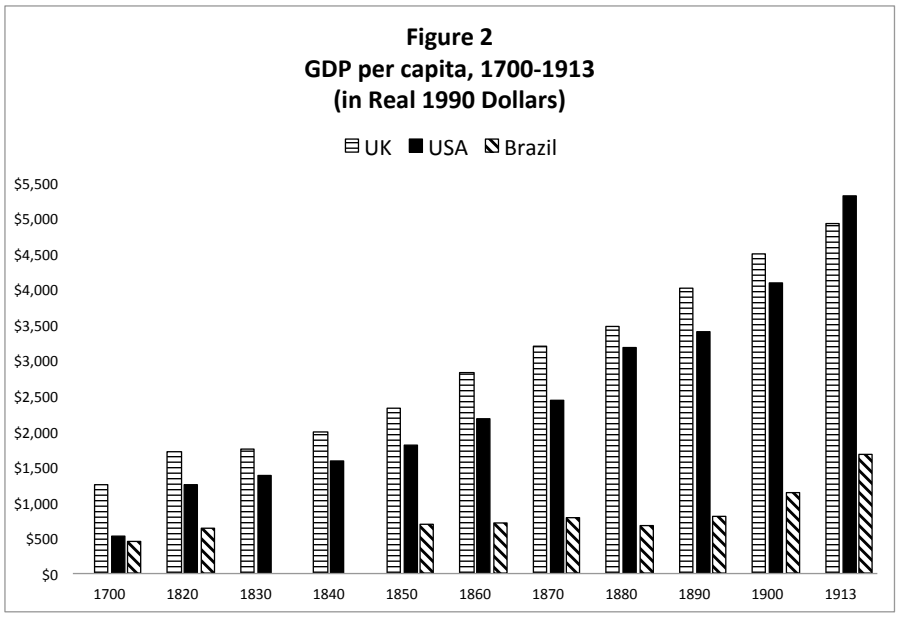
32 *See* B. Zorina Khan & Kenneth L. Sokoloff, *History Lessons: The Early Development of Intellectual Property Institutions in the United States*, 15 J. ECON. PERSP. 233, 235-36 (2001) [hereinafter Kahn & Sokoloff, *History Lessons*].

33 Some IP critics concede the point about the crucial role of patents in the long-run growth of the American economy, but go on to claim that recent administrative or legal changes have undermined the value of this earlier system. *See generally* JAFFE & LERNER, *supra* note 2.

34 The GDP per capita data is from Angus Maddison, *Statistics on World Population, GDP and Per Capita GDP, 1-2008 AD*, GRONINGEN GROWTH & DEV. CTR., http://www.ggdc.net/maddison/oriindex.htm (last visited May 11, 2016) (data directly retrievable at http://www.ggdc.net/maddison/Historical_Statistics/horizontal-file_02-2010.xls).

35 For a discussion of the development of national accounting, see NAT'L BUREAU OF ECON. RESEARCH, FIFTY YEARS OF ECONOMIC MEASUREMENT: THE JUBILEE OF THE CONFERENCE ON RESEARCH IN INCOME AND WEALTH (Ernst R. Berndt & Jack E. Triplett eds., 1991).



There are two salient patterns in Figure 2, the first of which is that there was a tremendous gap in national income between the United States and Great Britain during the colonial period. Circa 1700, per capita income in the United States was less than half that in Britain and only slightly higher than that in Brazil. Though we tend to forget it, the Thirteen Colonies were a poor and backward agrarian economy.[36] The cost of fighting the Revolutionary War, and the destruction caused by the war, did not help matters. The United States began its history as an independent country deeply mired in debt and in the midst of what historian Alan Kulikoff has termed "our first Great Depression."[37]

The second salient pattern of Figure 2 is that the United States not only caught up quickly with Britain, it surpassed it. By 1820, per capita income in the United States had reached roughly three quarters that of its former mother country. By 1913, its per capita income was higher than Britain's,

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36 The gap in development between the Thirteen Colonies and Britain was so large that the Continental Army would have lost the Revolutionary War had it not been for the fact that France and Britain were perennial rivals; and thus France provided the Americans with grants, loans, and arms, sent a combat army to serve under George Washington, and deployed their navy to fight Britain's off the U.S. coast. *See generally* JAMES BRECK PERKINS, FRANCE IN THE AMERICAN REVOLUTION (1911).

37 Allen Kulikoff, *"Such Things Ought Not To Be": The American Revolution and the First National Great Depression*, *in* THE WORLD OF THE REVOLUTIONARY AMERICAN REPUBLIC: LAND, LABOR, AND THE CONFLICT FOR A CONTINENT 134, 134 (Andrew Shankman ed., 2014). At the end of the Revolutionary War the United States was saddled with a debt equal to four to five times GDP, which is to say that it was more indebted by a factor of four than it has ever been since. CHARLES W. CALOMIRIS & STEPHEN H. HABER, FRAGILE BY DESIGN: THE POLITICAL ORIGINS OF BANKING CRISES AND SCARCE CREDIT 160 (2014).

and the United States was now one of the leading industrial nations of the world. This was decidedly not the outcome of other New World countries that obtained independence only a few decades after the United States—a fact made clear in Figure 2 by the stagnation, both absolute and relative, of Brazilian per capita income.

There are several pieces to the story of how the United States accomplished the rare feat of overtaking the economy of its former mother country, but there is uniformity of views among economic historians that the U.S. patent system played a large role. There was nothing ambiguous about the features of the Patent Act of 1790, one of the first acts that the first Congress passed.[38] As Professors Khan and Sokoloff explain,

> One goal was broad access to property rights in technology, which was achieved through low fees (less than 5 percent of what they were in Britain) and an application process that was impersonal and relied on routine administrative procedures. Incentives for generating new technological knowledge were also fine-tuned by requiring that the patentee be 'the first and true inventor' anywhere in the world and that the specifications of the invention be available to the public immediately on the issuance of the patent.[39]

The U.S. legal system reinforced the effectiveness of the 1790 patent law by developing rules and procedures to enforce the rights of patentees and their assignees—a history meticulously researched by Khan.[40] Supreme Court Justice Joseph Story made clear the perspective of the nation's highest Court in 1824:

> The inventor has . . . a property in his inventions; a property which is often of very great value, and of which the law intended to give him the absolute enjoyment and possession. . . . involving some of the dearest and most valuable rights which society acknowledges, and the constitution itself means to favor . . . .[41]

Patents were further strengthened by a major reform, the Patent Act of 1836, which introduced the examination system still in use today.[42] The scrutiny of patent applications by technically trained examiners reduced concerns third parties might have had about a patent's novelty, thereby facilitating the evolution of a market for patented technologies.[43]

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38 Act of Apr. 10, 1790 (Patent Act of 1790), ch. 7, 1 Stat. 109 (current version at 35 U.S.C. §§ 1-390 (2012)).

39 Kahn & Sokoloff, *History Lessons*, *supra* note 32, at 235 (quoting Patent Act of 1790 § 5, 1 Stat. at 111).

40 B. Zorina Khan, *Property Rights and Patent Litigation in Early Nineteenth-Century America*, 55 J. ECON. HIST. 58 (1995) [hereinafter Kahn, *Property Rights and Patent Litigation*].

41 *Ex parte* Wood, 22 U.S. (9 Wheat.) 603, 608 (1824); *accord* Kahn, *Property Rights and Patent Litigation*, *supra* note 40, at 73-74.

42 Kahn & Sokoloff, *History Lessons*, *supra* note 32, at 236.

43 *See id.*

The response of the American public was even more enthusiastic than the Founding Fathers imagined. By 1810, the United States surpassed Britain in patenting per capita. From the 1840s through the 1870s the per capita rate of patenting increased fifteen times.[44] As important as the numbers of patents was the fact that "the growth in patenting during the beginning of American industrialization was marked by a disproportionate increase in invention by ordinary citizens operating with relatively common skills."[45] Though these patents represented improvements in technologies across a broad array of economic sectors, it is telling that manufacturing accounted for roughly 40 percent of patents granted from 1790 to 1836.[46]

One possible concern with the large numbers of patents filed, especially by quite ordinary people, is that it might suggest that patenting played a trivial role incentivizing the really important inventions of the nineteenth century. Khan and Sokoloff therefore put together a data set of 160 early nineteenth century "great inventors," and found that virtually all of them made use of the patent system to appropriate returns to their efforts.[47] In fact, rather than practicing their inventions themselves, more than half of them licensed or assigned their patents to other firms or individuals.[48] Among these licensors were people whose names still adorn products today, such as Charles Goodyear, who invented the process for vulcanized rubber in 1839, but never manufactured or sold rubber products. Instead, Goodyear transferred his patent rights to other individuals and firms so that they could commercialize them.[49]

In the second half of the nineteenth century, an active market for invention developed. On the one hand, a class of specialized independent inventors with well-developed technical and scientific skills emerged. On the other hand, a class of patent brokers, patent agents, and patent attorneys developed to connect those inventors and their patents with manufacturers who either wanted to license or purchase them.[50] Then, as now, some of

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44 *Id.* at 239.

45 Kenneth L. Sokoloff & B. Zorina Khan, *The Democratization of Invention During Early Industrialization: Evidence from the United States, 1790-1846*, 50 J. ECON. HIST. 363, 364 (1990).

46 Kenneth L. Sokoloff, *Inventive Activity in Early Industrial America: Evidence From Patent Records, 1790-1846*, 48 J. ECON. HIST. 813, 824-25 (1988).

47 B. Zorina Khan & Kenneth L. Sokoloff, *"Schemes in Practical Utility": Entrepreneurship and Innovation Among "Great Inventors" in the United States, 1790-1865*, 53 J. ECON. HIST. 289, 289-90 (1993).

48 B. Zorina Khan & Kenneth L. Sokoloff, *Institutions and Democratic Invention in 19th-Century America: Evidence from "Great Inventors," 1790-1930*, 94 AM. ECON. REV. 395, 398 (2004).

49 Adam Mossoff, *Patent Licensing and Secondary Markets in the Nineteenth Century*, 22 GEO. MASON L. REV. 959, 962 (2015) [hereinafter Mossoff, *Patent Licensing and Secondary Markets*].

50 Naomi R. Lamoreaux & Kenneth L. Sokoloff, *Inventors, Firms, and the Market for Technology in the Late Nineteenth and Early Twentieth Centuries*, *in* LEARNING BY DOING IN MARKETS, FIRMS, AND COUNTRIES 19, 23 (Naomi R. Lamoreaux et al. eds., 1999); Naomi R. Lamoreaux & Kenneth L. Sokoloff, *Long-Term Change in the Organization of Inventive Activity*, 93 PROC. NAT'L ACAD. SCI. 12,686, 12,686-87 (1996); Naomi R. Lamoreaux & Kenneth L. Sokoloff, *Market Trade in Patents and*

these intermediaries were derided: the patent trolls of the twenty-first century were the "patent sharks" of the nineteenth century.[51]

Whatever they were called, there is no doubt that the market for invention in the second half of the nineteenth century played a critical role in the emergence of new industrial technologies and new industrial centers. Indeed, one would be hard pressed to make the case that patents in the nineteenth century, or the intermediaries who represented their inventors, did anything but facilitate the rapid development of American manufacturing. Then, as now, much of American innovation tended to cluster in particular cities or regions. As Professors Lamoreaux, Levenstein, and Sokoloff have shown, from the 1880s to the 1920s Cleveland, Ohio bore a strong resemblance to today's Silicon Valley, where local networks of firms and complementary educational, technological, and financial institutions helped to initiate and sustain waves of start-up enterprises.[52] Not only did Cleveland have a high rate of patenting, its manufacturing firms were intense users of those patented technologies—and, importantly, Cleveland was stunningly wealthy.[53]

III. LESSONS FROM LARGE-N STUDIES

How would one know if the experiences of Great Britain and the United States during the era of their initial industrial development generalize to the rest of the world today? One way to answer this question would be for researchers to conduct similar historical studies of patent laws and their enforcement, innovation, and economic outcomes for every other country in the world, and extend the time frame of those studies until the present day. The obvious limitation of this approach is that exploring how a country's institutions have changed over time and how its economy responded to those changes is not an enterprise characterized by increasing returns to

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the Rise of a Class of Specialized Inventors in the 19th-Century United States, 91 AM. ECON. REV. 39, 39 (2001) [hereinafter Lamoreaux & Sokoloff, *Market Trade in Patents*]; Naomi R. Lamoreaux, Kenneth L. Sokoloff & Dhanoos Sutthiphisal, *Patent Alchemy: The Market for Technology in US History*, 87 BUS. HIST. REV. 3, 22-24 (2013). *See generally* B. ZORINA KHAN, THE DEMOCRATIZATION OF INVENTION: PATENTS AND COPYRIGHTS IN AMERICAN ECONOMIC DEVELOPMENT, 1790-1920 (2005).

51 Gerard N. Magliocca, *Blackberries and Barnyards: Patent Trolls and the Perils of Innovation*, 82 NOTRE DAME L. REV. 1809, 1811 (2007); Mossoff, *Patent Licensing and Secondary Markets*, *supra* note 49, at 959.

52 Naomi R. Lamoreaux et al., *Mobilizing Venture Capital During the Second Industrial Revolution: Cleveland, Ohio, 1870-1920*, 1 CAPITALISM & SOC'Y, no. 3, 2006, at 1, 1-3 [hereinafter Lamoreaux et al., *Mobilizing Venture Capital*]; Naomi R. Lamoreaux et al., *Financing Invention During the Second Industrial Revolution: Cleveland, Ohio, 1870-1920*, *in* FINANCING INNOVATION IN THE UNITED STATES, 1870 TO THE PRESENT 39, 42 (Naomi R. Lamoreaux & Kenneth L. Sokoloff eds., 2007).

53 Lamoreaux et al., *Mobilizing Venture Capital*, *supra* note 52, at 3.

scale. Obviously, more historical studies that dispassionately look at the evidence are called for, but scaling up the kind of work that has been done on Great Britain and the United States to the entire world would be a prodigious task.

A second way to answer this question, one employed by a growing number of researchers, is to employ econometric methods on data similar to that which we have used to draw Figure 1. As a preamble to a discussion of this literature, we should make clear that the accurate econometric estimation of causal relationships, what researchers call "clean identification," requires considerable care, and that econometric research on the impact of patents on innovation and economic growth is a relatively young area of intellectual inquiry.[54] This Essay can obviously not provide readers with a critical survey of every study conducted, but suffice to say that researchers need to make tradeoffs between the choice of statistical method, the measurement of patent strength, and the measurement of innovation.

One approach to getting cleaner identification than provided in Figure 1 is to exploit the dimension of time; rather than asking whether there is a correlation in levels of patent rights and levels of innovation across countries, researchers ask whether innovation increases in countries after they strengthen patent rights. This strategy allows researchers to expunge the effect of possible unobserved confounders—time invariant characteristics of countries—that might be correlated with patent rights and innovation. An even larger improvement to causal inference is made by simultaneously exploiting both variance over time and variance across countries by asking an even more difficult question: after a country strengthens patent rights, does its rate of innovation increase relative to the rate of innovation of other countries that were just like it prior to its change in patent law?

These improvements in identification do, however, come with their own complications, one of which is measurement error. Some studies use measures of patent rights that only capture laws on the books, not the quality of their enforcement.[55] Other studies measure patent rights with even blunter measures, such as dummy variables to capture episodes of major change in patent law.[56] Noisy proxies are also used to measure innovation, such as counting number of patents.[57]

The well-known limitations of these measures are of relatively minor concern when one is drawing a static comparison across countries; their cross-sectional variation is large relative to the degree to which they potentially incorrectly measure patent rights and innovation. When researchers

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54 Econometric research in this area did not begin to flourish until Ginarte and Park created an index of patent rights in 1997. *See* Ginarte-Park, *supra* note 7, at 283.

55 *Id.* at 286.

56 *See* Josh Lerner, *The Empirical Impact of Intellectual Property Rights on Innovation: Puzzles and Clues*, 99 AM. ECON. REV. 343, 347 (2009).

57 *See id.*

start to look for relationships between patent rights and innovation within countries over time—variations that are likely to be subtle and incremental—the ratio of measurement error to variation in the dependent and independent variables grows; measurement error now becomes a serious cause for concern. Some recent work that employs time-series-centric methods has therefore measured patent rights by combining measures of statutory laws with measures of the quality of legal enforcement[58] (as Figure 1 does). Some recent work has also measured innovation by looking at less noisy indicators than patent counts, such as value added or spending on R&D in industries that are heavily patent-dependent.[59]

A second serious complication with statistical techniques that exploit variance within countries over time is that they either require a lot of independent variation in the measure of patent rights within countries over time, or they require data series with very long time dimensions. Basically stated, econometricians draw inferences by determining whether changes in X covary with changes in Y. But, what if X changes infrequently, those changes are incremental in nature, and Y responds to changes in X gradually—as is the case with the correlation of strength of patent protection and rates of innovation?

Consider, for example, the invention of the laser and the commercialization of the products it spawned. The body of law under which the first laser patent application was filed, the 1952 Patent Act, preceded that application by seven years.[60] When the patent was granted in 1960, no one imagined the laser's application in laser pointers, laser printers, laser beam welders, laser surgery, laser cutting, barcode scanners, 3D printing, optical disk drives (e.g., CDs, DVDs), and fiber-optic information transmission (without which there would be no high speed internet).[61] That process of follow-on innovation, which applied lasers to a wide range of complementary technologies, has spanned more than half a century, and it is still not complete.

Confronting the combined problem of measurement error, data series with short time spans, and dependent variables that adjust gradually is not straightforward. Inappropriate methods applied to noisy proxies may give rise to weak tests of the null hypothesis. Researchers may therefore draw spurious inferences.

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58 *See* Hu & Png, *supra* note 7, at 677; *see also* Zhang et al., *supra* note 7, at 5.

59 *See* Philippe Aghion et al., *Patent Rights, Product Market Reforms, and Innovation*, 20 J. ECON. GROWTH 223, 224 (2015).

60 *Bright Idea: The First Lasers*, AM. INST. PHYSICS, https://www.aip.org/history/exhibits/laser/sections/whoinvented.html (last visited May 11, 2016).

61 *See id.* The history of the laser might encourage scholars who claim that Patent Assertion Entities (PAEs) frustrate innovation through expensive litigation to reconsider their claims. The initial laser patents were subject to three decades of expensive litigation, but the value of laser-based products exceeds the cost of those lawsuits by many orders of magnitude. The inventor who ultimately prevailed in court against the USPTO financed his long fight by founding a PAE.

One example of a weak test of the null is the widely cited study by Professor Josh Lerner, which measures the impact of changes in patent laws using event study methods. Instead of asking whether the strengthening of patents pushes an economy onto a permanently higher long-run equilibrium level of innovation, he asks whether the strengthening of patents affects the rate of change of innovation in an economy within a two-year window after a patent reform.[62] This is a weak test because individuals and business enterprises neither adjust to changes in legal regimes in an immediate and discontinuous manner, nor do they complete follow-on innovations after an initial, break-through invention in an immediate and discontinuous manner. The example of the laser, which we discussed above, suggests that follow-on innovations develop over decades, not two-year windows. Even with this limitation in Lerner's identification strategy, his base specification finds a positive relationship between the strengthening of patent rights and changes in innovation.[63] It is only when he adjusts the data to control for changes in rates of innovation in the ten countries with the longest spans of data, which includes the most patent intensive countries in the data set, such as the United States and Great Britain, that his tests yield results consistent with the hypothesis that there is no relationship between patent strength and innovation.[64]

How have researchers mitigated the problems inherent in econometric approaches to the study of patents, and what have we learned from those studies? One approach to mitigating the problems caused by the analysis of infrequent events is to maximize the number of those events and the responses to them by developing data sets with a very long time dimension. Qiang Chen takes this approach by building two panel data sets, one that spans 1750 to 1950, and another that spans 1590 to 1900, covering fifteen developed countries. He finds that there is a significant positive effect of patent laws on innovation rates, even after controlling for the size of economies.[65] His results are robust to the inclusion of country-fixed effects, as well as dropping the United States and the United Kingdom from the regressions.[66]

Professors Hu and Png, in a particularly impressive piece of research, use a difference-in-differences estimator applied to data with a relatively low noise-to-signal ratio. They ask whether changes in the strength of patent rights results in more patent-intensive industries experiencing faster growth in value added than in less patent-intensive industries. They control for possible time-varying confounders, such as financial development, hu-

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62 Lerner, *supra* note 56, at 344.

63 *Id.* at 344.

64 *Id.* at 344-45.

65 *See* Qiang Chen, *The Effect of Patent Laws on Invention Rates: Evidence from Cross-Country Panels*, 36 J. COMP. ECON. 694, 694 (2008).

66 *Id.*

man capital, and trade openness. They also draw on a database that comprises four panels of up to fifty-four different manufacturing industries in seventy-one countries.[67]

Hu and Png find that patent intensive industries in countries that improve the strength of patents experience faster growth in value added than less patent-intensive industries in those same countries.[68] They also find that the effect of an increase in patent strength is larger in more developed economies.[69] That is, patent rights matter for economic growth but, as shown in Figure 1, there are non-linearities. They also find that the positive effects of stronger patent rights came about both by encouraging investment and by technical progress.[70]

Professors Zhang, Du, and Park mitigate the intersecting problems of measurement error and infrequent events by borrowing techniques from the cross-country growth accounting literature. Rather than looking at year-over-year changes in patent rights and innovation, they look at average rates of change in both variables over long windows of time, and then control for a range of other factors that also changed over those windows of time.[71] They not only find that there is a positive relationship between the strength of enforceable patent rights and innovation in developed economies, but that that relationship holds for underdeveloped economies as well.[72]

What, then, are the consensus findings from the econometric literature? While there is still work to be done, there is a critical mass of multi-country studies, and it points toward two conclusions.[73] First, there is a causal relationship between the strength of patent rights and innovation.

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67 Hu & Png, *supra* note 7, at 676.

68 *Id.*

69 *Id.*

70 *Id.* at 677.

71 Zhang et al., *supra* note 7, at 3.

72 *Id.*

73 *See* Lee Branstetter et al., *Does Intellectual Property Rights Reform Spur Industrial Development*?, 83 J. INT'L ECON. 27 (2011); Chen, *supra* note 65; Hu & Png, *supra* note 7; Zhang et al., *supra* note 7. *See generally* Walter G. Park, *Do Intellectual Property Rights Stimulate R&D and Productivity Growth? Evidence from Cross-National and Manufacturing Industries Data*, *in* INTELLECTUAL PROPERTY AND INNOVATION IN THE KNOWLEDGE-BASED ECONOMY 9-1 (Jonathan D. Putnam ed., 2003); Aghion et al., *supra* note 60; Brent B. Allred & Walter G. Park, *Patent Rights and Innovative Activity: Evidence from National and Firm-Level Data*, 38 J. INT'L BUS. STUD. 878 (2007); Kristie Briggs & Walter G. Park, *There Will Be Exports and Licensing: The Effects of Patent Rights and Innovation on Firm Sales*, 23 J. INT'L TRADE & ECON. DEV. 1112 (2014); Iftekhar Hasan & Christopher L. Tucci, *The Innovation–Economic Growth Nexus: Global Evidence*, 39 RES. POL'Y 1264 (2010); Sunil Kanwar & Robert Evenson, *Does Intellectual Property Protection Spur Technological Change?*, 55 OXFORD ECON. PAPERS 235 (2003); Yi Qian, *Do National Patent Laws Stimulate Domestic Innovation in a Global Patenting Environment? A Cross-Country Analysis of Pharmaceutical Patent Protection, 1978–2002*, 89 REV. ECON. & STAT. 436 (2007); Daniel Lederman & Laura Saenz, *Innovation and Development Around the World, 1960-2000* (World Bank, Policy Research Working Paper No. 3774, 2005).

Second, this relationship is non-linear: there are threshold effects such that stronger patent rights positively impact innovation once a society has already reached some critical level of economic development. The reason for the non-linearity probably resides in the fact that innovation is not just a product of the strength of patent rights, but of other features of societies, which are necessary complements, that tend to be absent at low levels of economic development. For example, absent a financial system that allocates credit to the private sector, ideas for inventions will languish and innovations based on those inventions will never be commercialized.[74] Chen suggests that there are similar complementarities between the strength of patent rights and levels of education.[75] Recent work by Zhang, Du, and Park indicates that once some of these complementarities are controlled for, the threshold effects disappear: countries at all levels of economic development benefit from stronger patents.[76]

IV. MAYBE THIS TIME IS DIFFERENT?

Is it possible that these lessons from economic history and from econometric studies are not applicable to the United States at the beginning of the twenty-first century? Perhaps the current U.S. innovation ecosystem is sui generis because of the emergence of Patent Assertion Entities ("PAEs")—pejoratively known as "patent trolls," firms that purchase patents and then seek licensing revenues from operating companies through litigation or the threat of litigation. Or, perhaps the innovation ecosystem of the United States is sui generis because it is a world leader in the production of complex digital products that did not exist until quite recently, and that are susceptible to "patent holdup" (strategic behavior by the owner of a Standard Essential Patent ("SEP") in order to charge a licensing fee in excess of the patent's true economic contribution to the product).

In order to address these concerns we need to ask two questions: First, are PAEs and "patent holdup" new features of the U.S. innovation ecosystem, and second, does the weight of the evidence suggest that they hinder innovation? If the answer to *both* questions is yes, then we should be cautious about drawing inferences from the economic history and econometric literatures about the relationship between patents and innovation in the contemporary United States. If the answer to *either* question is no, however, we

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74 There is, in fact, a consensus body of research by economic historians and financial economists demonstrating the crucial role that finance plays in innovation. *See* Ross Levine, *Finance and Growth: Theory and Evidence*, 1A HANDBOOK OF ECONOMIC GROWTH 865 (Philippe Aghion & Steven N. Durlauf eds., 2005). For a discussion of why stable and efficient financial systems are uncommon, see CALOMIRIS & HABER, *supra* note 37.

75 Chen, *supra* note 65.

76 Zhang et al., *supra* note 7, at 27.

are on surer footing in drawing inferences from the economic history and econometric literatures about the contemporary United States.[77] An examination of the evidence about PAEs and patent holdup suggests that the answer to *both* questions is no; there are good reasons to think that the evidence from economic history and econometric research are indeed applicable to the contemporary United States.

There is a large and lively literature on PAEs. Some studies claim that PAEs are a new business model based on the extraction of rents from operating companies via nuisance lawsuits.[78] They therefore constitute a direct tax on innovation—a cost that James Bessen and Professor Michael Meurer put at $29 billion per year.[79] An impressive, interdisciplinary array of researchers and scholars, however, finds that at earlier points in U.S. history, specialized firms emerged that acquired patents in order to seek licensing revenues and litigated aggressively when their patents were infringed.[80] As Khan notes: "The 'great inventors' of the nineteenth century, who were responsible for major disruptive technological innovations, were especially likely to be, or to benefit from, 'nonpracticing entities.'"[81] She also undertakes an analysis of rates of litigation (patent lawsuits divided by the number of patents filed) from 1790 to 2012, and finds,

> [H]istorical 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

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77 Imagine, for a moment, that PAEs and patent holdup are recent phenomena, but that the evidence for the claim that they hinder innovation is weak or non-existent. The lack of evidence about the hindrance of innovation would make their new-ness irrelevant. Imagine, conversely, that the evidence indicates that PAEs and patent holdup do hinder innovation, but that they are not new phenomena. The implication would be that the lessons from economic history apply to the contemporary United States, because the negative effects of PAEs and patent holdup would have also operated during the period when the patent system supported America's rise to a global economic power.

78 *See* James Bessen & Michael Meurer, *The Direct Costs from NPE Disputes*, 99 CORNELL L. REV. 387, 404-05 (2014).

79 *Id.* at 389; *see also* James Bessen et al., *The Private and Social Cost of Patent Trolls*, REGULATION, Winter 2011, at 26, 31 (estimating the loss at $83 billion per year from 2007 to 2010 in 2010 dollars). *But see* Michael Risch, *Framing the Patent Troll Debate*, 24 EXPERT OPINION ON THERAPEUTIC PATENTS 127 (2014); Michael Risch, *Patent Troll Myths*, 42 SETON HALL L. REV. 457, 458-60 (2012) (arguing that NPEs are a microcosm of innovative markets).

80 *See* Naomi R. Lamoreaux & Kenneth L. Sokoloff, *Intermediaries in the U.S. Market for Technology, 1870-1920*, *in* FINANCE, INTERMEDIARIES, AND ECONOMIC DEVELOPMENT 209 (Stanley L. Engerman et al. eds., 2003); Khan, *Trolls and Other Patent Inventions*, *supra* note 31, at 832-34; Lamoreaux & Sokoloff, *Market Trade in Patents*, *supra* note 50, at 39; Lamoreaux, Sokoloff & Sutthiphisal, *supra* note 50, at 4; Mossoff, *Patent Licensing and Secondary Markets*, *supra* note 49, at 960-62.

81 Khan, *Trolls and Other Patent Inventions*, *supra* note 31, at 833.

> significant market expansion that started in the 1870s and heralded a "second industrial revolution" that dramatically improved living standards.[82]

Lamoreaux, Sokoloff, and Sutthiphisal summarize the evidence as follows: "Opportunism in the market for technology gets much more media attention nowadays than it did in the nineteenth century. However, it is not clear that the 'troll' problem is commensurately more serious than it was in the earlier period."[83]

There is also no convincing evidence that PAEs negatively affect innovation. Professors Schwartz and Kesan, for example, analyze the data and methods employed by Bessen and Meurer to produce the widely cited claim that in 2011 PAEs generated a direct tax on innovation of $29 billion. Their analysis effectively undermines the Bessen-Meurer claim.[84]

Kesan and Schwartz point out that the Bessen-Meurer estimate is generated from a survey of eighty-two business enterprises regarding their experiences with PAE litigation, but those firms were neither randomly selected nor chosen so as to generate a representative sample. Rather, Bessen and Meurer relied on a survey sent to "'about 250 companies,' which include 'RPX clients and nonclient companies with whom RPX has relationships.'"[85] RPX is a business enterprise that describes itself as a defensive patent aggregator.[86] There are therefore multiple reasons to be concerned about sample selection bias.

Kesan and Schwartz also demonstrate that Bessen and Meurer conflate "costs" with "transfers." Slightly less than one-quarter of their $29 billion figure ($6.7 billion) represents actual litigation costs; the vast majority of the $29 billion is composed of settlement, licensing, and judgment amounts, which are the rewards that patent holders should have received for their intellectual property in the absence of infringement.[87]

Kesan and Schwartz also point out that Bessen and Meurer do not ask whether the $6.7 billion in litigation costs is a large number in relation to some benchmark. They ask how $6.7 billion compares to the amounts spent by operating companies that regularly sue each other for patent infringe-

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82 *Id.* at 837.

83 Lamoreaux, Sokoloff & Sutthiphisal, *supra* note 50, at 36 (footnote omitted).

84 David L. Schwartz & Jay P. Kesan, *Analyzing the Role of Non-Practicing Entities in the Patent System*, 99 CORNELL L. REV. 425, 431-43 (2014) (reviewing and criticizing Bessen & Meurer, *supra* note 78); *see also* Christopher A. Cotropia, Jay P. Kesan & David L. Schwartz, *Unpacking Patent Assertion Entities (PAEs),* 99 MINN. L. REV. 649 (2014); Christopher A. Cotropia et al., *Heterogeneity Among Patent Owners in Litigation: An Empirical Analysis of Settlement, Case Progression, and Adjudication* (Conf. on Empirical Legal Stud., Wash. Univ., paper presented Oct. 31, 2015), http://hq.ssrn.com/ViewPdf.cfm?abid=2629453.

85 Schwartz & Kesan, *supra* note 84, at 434 (quoting Bessen & Meurer, *supra* note 78, at 394).

86 *Id.*

87 *Id.* at 438-39.

ment (e.g., cases such as Apple v Samsung).[88] We would point out deadweight losses are usually assessed as a percentage of GDP,[89] and on that basis the $6.7 billion in PAE litigation costs in 2011 amounted to only 0.05 percent of America's $15.5 trillion national product. To put this in context, $6.9 billion was the amount Americans spent in 2015 on Halloween.[90]

Finally, Kesan and Schwartz note that any analysis of costs must be balanced by an analysis of benefits, but these are ignored by Bessen and Meurer.[91] Recall here the history of the laser. The initial patents generated lengthy and costly litigation financed by a PAE. But who would maintain that those costs represented a deadweight loss to the U.S. economy in light of the hundreds of billions of dollars generated by the commercialization of laser-based products over the past five decades?

The claim that the innovation ecosystem of the contemporary United States is sui generis because of "patent holdup" is equally problematic. While today's digital products do indeed require a higher degree of interoperability and compatibility across multiple platforms than was the case earlier in American history, there is neither anything new about products being composed of complex combinations of hundreds of patents owned by a wide variety of individuals and firms,[92] nor is there anything new about firms whose sole source of revenue comes from the licensing of essential patents.[93]

There is also little empirical evidence that patent holdup hinders innovation. An extensive theoretical literature examines the possibilities for patent holdup in products that are dependent upon SEPs, such as cell phones, video equipment, and personal computers.[94] The evidence in support of this theory, however, is largely anecdotal.[95]

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88 *Id.* at 440.

89 *See* Douglas A. Irwin, *Trade Restrictiveness and Deadweight Losses from US Tariffs*, 2 AM. ECON. J.: ECON. POL'Y 111, 121 (2010).

90 *Halloween Spending Summary*, NAT'L RETAIL FED'N, http://research.nrffoundation.com/Default.aspx?pg=108#.VpmD9xUrLIU (last visited May 11, 2016).

91 Schwartz & Kesan, *supra* note 84, at 439.

92 Khan, *Trolls and Other Patent Inventions*, *supra* note 31, at 839.

93 Mossoff, *Patent Licensing and Secondary Markets*, *supra* note 49, at 965-66.

94 *See* Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, *in* 1 INNOVATION POLICY AND THE ECONOMY 119, 141 (Adam Jaffe et al. eds., 2001). *See generally* Joseph Farrell et al., *Standard Setting, Patents, and Hold-up*, 74 ANTITRUST L.J. 603 (2007); Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991 (2007); Joseph Scott Miller, *Standard Setting, Patents, and Access Lock-In: RAND Licensing and the Theory of the Firm*, 40 IND. L. REV. 351 (2007); Daniel G. Swanson & William J. Baumol, *Reasonable and Nondiscriminatory (RAND) Royalties, Standards Selection, and Control of Market Power*, 73 ANTITRUST L.J. 1 (2005).

95 Jonathan M. Barnett, *From Patent Thickets to Patent Networks: The Legal Infrastructure of the Digital Economy*, 55 JURIMETRICS J. 1, 2-5 (2014); Damien Gerardin et al., *The Complements Problem*

Professors Galetovic, Haber, and Levine examine one of the core testable implications by drawing on an extensive economics literature on the measurement of productivity growth, which has shown that there is virtually a one-to-one relationship between changes in quality-adjusted relative prices and differential rates of innovation across industries.[96] If the patenting system empowers SEP holders to negotiate excessive royalty payments and in turn slows innovation by discouraging investment and market entry, then products that are SEP-intensive should experience slower declines in quality-adjusted relative prices than products that are not SEP-intensive.

Galetovic, Haber, and Levine apply a range of approaches to data series compiled by the U.S. Department of Commerce on quality-adjusted relative prices of SEP-intensive and non-SEP-intensive products. These approaches include comparisons of SEP and non-SEP digital products that are affected by Moore's Law, as well the use of a difference-in-differences estimator applied to detrended data to control for potential differences in underlying innovation rates by product.[97] Regardless of how they treat the data, however, they cannot reject the null hypothesis of no patent hold-up.

CONCLUSION

The goal of social science is not to show that one is right—and that those disagreeing are wrong, or wicked—it is to show that the weight of the evidence indicates that one is probably not wrong. Generally speaking, no single piece of evidence, no single article, no single method, no single approach to evidence should be viewed as dispositive. It is, however, telling that the weight of the evidence from two very different bodies of scholarship, employing very different approaches to evidence—one based on mastering the facts of history, the other based on statistical modeling—yield the same answer: there is a causal relationship between strong patents and innovation. One also has to sit up and take notice when that answer squares with a generally accepted theory about the fundamental role of clearly defined and impartially enforced property rights in generating the wealth of nations.

Evidence and reason therefore suggest that the burden of proof falls on those who claim that patents frustrate innovation. Convincing scholars who are not predisposed to accept that claim will require IP critics to: (1) develop a coherent theory based on first principles about why patent rights are fundamentally different from other property rights; (2) test that theory

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Within Standard Setting: Assessing the Evidence on Royalty Stacking, 14 B.U. J. SCI. & TECH. L. 144, 160 (2008).

96 Alexander Galetovic, Stephen Haber & Ross Levine, *An Empirical Examination of Patent Holdup*, 11 J. COMPETITION L. & ECON. 549, 561 (2015).

97 *Id.* at 571-72.

against carefully retrieved historical facts and appropriately specified statistical models; and (3) consider their theory and evidence in light of alternative theories and alternative evidence in a dispassionate manner.