PATENTLY GOOD

A defence of intellectual property

By Ben Southwood

BRIEFING PAPER

EXECUTIVE SUMMARY

- Property rights are good not "just because", but because of how they contribute to human flourishing
- Patents are, like other property rights, an automatic market mechanism making use of decentralised information and robust to shocks, unlike prizes, which require some sort of central direction
- Patents encourage information to come into the open, but they limit how you can use that info
- Intellectual property rights can be too stringent, but it's unclear whether we've reached that point yet

PHILOSOPHY

Many libertarians are very sceptical of intellectual property. It might seem strange to a non-libertarian—libertarians love property rights!—but it's obvious why if considered carefully. Property rights over your body, your land, your house and your tools are in direct conflict with intellectual property: if someone has a right to control how an idea is used, it prevents you from using the things you "really" own in ways that you like.

If Apple has a right to the Apple logo, I can't draw it on my house or car and sell stuff out of them. If Apple has a right over using a type of glass in phones I can't use my factory, my machine tools, my raw materials and indeed my hands and thoughts in ways I very well might want to.

Many are convinced by the elegance of Roderick Long's argument:[1]

> *Information is not a concrete thing an individual can control; it exists in other people's minds and other people's property, and over these the originator has no legitimate sovereignty. You cannot own information without owning other people.*

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1 http://freenation.org/a/f31l1.html

> *Suppose I write a poem, and you read it and memorize it. By memorizing it, you have in effect created a "software" duplicate of the poem to be stored in your brain. But clearly I can claim no rights over that copy so long as you remain a free and autonomous individual. That copy in your head is yours and no one else's.*
>
> *But now suppose you proceed to transcribe my poem, to make a "hard copy" of the information stored in your brain. The materials you use — pen and ink — are your own property. The information template which you used — that is, the stored memory of the poem — is also your own property. So how can the hard copy you produce from these materials be anything but yours to publish, sell, adapt, or otherwise treat as you please?*

But this seems misguided. The reason regular property rights are good is not because we have a fundamental moral right to sovereignty over certain objects. Robert Nozick is wrong that "mixing labour" with things makes them morally yours in a way that other considerations can never trump.[2] In fact the reason that property rights are good institutions is that they make us happier and freer, and that they have good consequences: rich societies where individuals feel autonomous under a rule of law.[3]

WHY PROPERTY RIGHTS WORK

Though the two sorts of rights conflict, the justification for both is closely analogous. All property rights, even property rights over one's own body—self-ownership—are monopolies. Exclusive ownership generates investment. It is not from the benevolence of the butcher or baker that we expect lunch, but from their regard to their self interest.

If fields are owned in common, they produce a lot less. Most people are somewhat selfish, and do not improve fields when they stand to benefit only very little from each marginal improvement. They eat the seed corn. A field that will feed 10 would feed 100 or 1,000 if separated into many privately owned plots.[4] Indeed: an individual can feed themselves off far less land if they own it exclusively than the share they effectively use when it is part of the commons.[5]

Some restrictions on property rights are good. Doctrinaire libertarians have arguments over not just redistribution, but even simple questions like whether it's okay to break into someone's mountain hut to get shelter in a blizzard. But it's obvious to nearly everyone else that some restrictions on property rights make the world better. This approach accepts that automatically: property rights are there for human flourishing and rule-of-law systems build some beneficial restrictions into those property rights.

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2 Nozick, R. (2013). *Anarchy, state, and utopia*. Basic books.

3 Gintis, H. (2007). The evolution of private property. *Journal of Economic Behavior & Organization*, 64(1), 1-16.

4 Locke, J. (2014). *Second Treatise of Government: An Essay Concerning the True Original, Extent and End of Civil Government*. John Wiley & Sons.

5 Cohen, G. A. (1995). *Self-ownership, freedom, and equality*. Cambridge University Press.

Things are similar, at least in principle, for ideas. If you give people monopoly control of their idea then they may produce—or share—more ideas. If an idea is genuinely new, then its being produced or shared with you makes you better off and freer. It gives you more options, not fewer. It's all well and good to say I am restricted by not being able to make iPhones—but would I really have been able to make them without Apple?

MARKET RENTS

Market power is when a firm can charge more than the cost of making a new unit, because of barriers to entry. In a competitive market where firms rent their capital, they can only charge marginal cost: if not, other firms would pop up and steal the market by undercutting them. Some of the most competitive real live markets are close to this—supermarkets make tiny margins and offer near-identical prices. But most markets are to some degree away from this.

This means there are rents. In an extreme case these are monopoly rents. Imagine you own and run a railway between Manchester and Leeds. Building and operating a new one costs a lot, and this new railway would have to charge lower prices to attract customers. Assuming there are no other modes of transport then this gap—expected potential profits—determines what prices the monopolist can set before they'll face competition. The gap between a competitive price and the monopoly price is a rent. This is a pure redistribution from users of the network to whoever happens to own it.

It helps to distinguish between barriers to entry and costs of entry. If building a new railway was trivial technically, and the only cost was regulatory—e.g. you had to pay off a corrupt bureaucrat but rails appeared magically—then potential competitors face barriers to entry. Real costs that society has to bear—like using workers, capital, and management or entrepreneurship to organise building a railway line instead of doing something else—are costs of entry.

Barriers to entry reduce competition with no corresponding benefit, but when there are large costs of entry, the loss of competition is balanced by keeping resources spare. Competition requires "unnecessary duplication", something that greatly troubled early socialists and led them to believe that the socialist economy would not only be more moral than the capitalist one, but more efficient.[6]

In any case, a canny monopolist will set prices such that no competitor enters, enjoying their rents for as long as possible. Modern regulators aim to set prices so that natural monopolies do not earn rents, and consumers get higher consumer surplus instead. So far, so sensible. But this approach has a key defect: it requires Herculean feats of innovative winner-picking when you consider the economy as dynamic, not static.

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6 Mankiw, N. G., & Whinston, M. D. (1986). Free entry and social inefficiency. *The RAND Journal of Economics*, 48-58.

This is because rents that are caused by costs of entry (but not those caused by barriers to entry) are automatic prizes that reward entrepreneurs in direct proportion to how much they can alleviate inefficiency in the marketplace. Higher rents not only motivate investment, as in the example above, where someone might build a second railway (or indeed a road, canal, bus service, or air link) between Manchester and Leeds, but also innovation.

This is quite general. Some innovation does not take away profits, but instead reduces the need for labour, land, or capital. But the cost of these is a rent too—a factor rent. Just as we don't see these as fixed, nor should we see market rents as fixed. As long as we think innovation is reasonably possible, we should be open to allowing market rents to exist to direct innovation. Efficiency-enhancing innovations do not fall like manna from heaven—they come from where we focus our research activities as a society.

RENTS & INTELLECTUAL PROPERTY

It's obvious how this applies to intellectual property. When I have a patent to produce a drug, if this drug is useful I will earn large rents. But it is precisely those rents that indicate that finding a substitute is so valuable. If a firm can find a close substitute, they stand to get some of those rents for themselves—driving innovation into the highest value areas. So we should be more sanguine about less competitive markets and natural monopolies—where competition is restrained by facts of the world, not regulation—they help tell us where improvement is most valuable. And they pay people for doing that improvement!

The spillover benefits from new ideas are gigantic. A recent review suggests the total benefit to society of an extra pound of research and development is four or more times the benefit to the firm.[7] This is even under a system of extensive intellectual property protection. When you take a longer view, the positive externalities of innovation become yet larger, despite patent monopolies. William Nordhaus found that in the long run, even under our extensive intellectual property system, innovators captured around 2% of the gains from their inventions—society at large captured the rest.[8] Even in a shorter time-frame the gains to society are more than twice as large as the gains to firms who innovate.[9]

Of course, it is an empirical question as to whether inventions are endogenous—affected by policy and incentives—or whether they are destined to appear exogenously at a given time. Perhaps incentive structures like patents only bring inventions forward very slightly, and they would always have been invented at pretty much the same time, just by someone else. This is, of course, an empirical question, but this does not appear to be the world we live in.[10]

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7 Lucking, B., Bloom, N., & Van Reenen, J. (2017). Have R&D Spillovers Changed?.

8 Nordhaus, W. D. (2004). *Schumpeterian profits in the American economy: Theory and measurement* (No. w10433). National Bureau of Economic Research.

9 Bloom, N., Schankerman, M., & Van Reenen, J. (2013). Identifying technology spillovers and product market rivalry. *Econometrica*, 81(4), 1347-1393.

10 Haber, S. (2015). Patents and the Wealth of Nations. *Geo. Mason L. Rev.*, 23, 811.

ASYMMETRIES

This centrality of rents illustrates an asymmetry when it comes to patent rights. Bringing in, or strengthening patent rights creates monopolies, but these monopolies contain the seeds of their own downfall: the more restrictive they are the more there is a dynamic incentive to invent around them.[11] [12] By contrast, invalidations and weakenings drive no such market response. If they weaken rights too much there is no automatic mechanism that balances is this out over time. This is precisely what we see in pharmaceuticals, where more exclusivity clearly leads to research and development leading to the invention of substitutes.[13]

FOLLOW-ON INNOVATION

The potential trade-off is follow-on innovation. Yes, patents may promote innovation. But they also restrict it: you cannot freely improve on the ideas of others if they have patented them, at least until their patent expires. Their patent may encompass uses that you would have come up with, or propagated, but which they never discover or make use of. These are developed and spread later due to the restrictions the system imposes.

But patents also promote follow-on innovation. Isaac Newton discovered calculus but did not share his discovery for years.[14] Similarly, many of the technologies used to measure longitude at sea—funded by grants and progress prizes—were kept secret until patents prompted disclosure. [15]When you register a patent you get exclusive rights, but you must also bring the idea into the public domain. Without patents, firms would have an incentive to be extremely secretive and keep crucial ingredients from the scientific and research community.

THE TABARROK CURVE

Indeed, the libertarian approach seems silly when you consider that a few mostly cosmetic changes would make the current system look very similar in practice to the "libertarian" one.[16] Firms could just require all consumers or clients to sign end-user license agreements agreeing not to share any info about the new innovations. If these were legally binding, these might give inventors infinite effective monopoly rights over their innovations—without violating any regular property rights. Anyone party to the information will have agreed, freely and contractually, not to share any of the contained information.

It might also matter what level of protection you are at. Instituting short, clear, restrictive patents may increase innovation, but expanding these into long and fuzzy

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11 Easterbrook, F. H. (1984). Limits of antitrust. *Tex. L. Rev.*, 63, 1.

12 Manne, G. A., & Wright, J. D. (2010). *Innovation and the Limits of Antitrust. Journal of Competition Law and Economics, 6(1)*, 153-202.

13 Gilchrist, D. S. (2016). Patents as a Spur to Subsequent Innovation? Evidence from Phar. *American Economic Journal: Applied Economics, 8(4)*, 189-221.

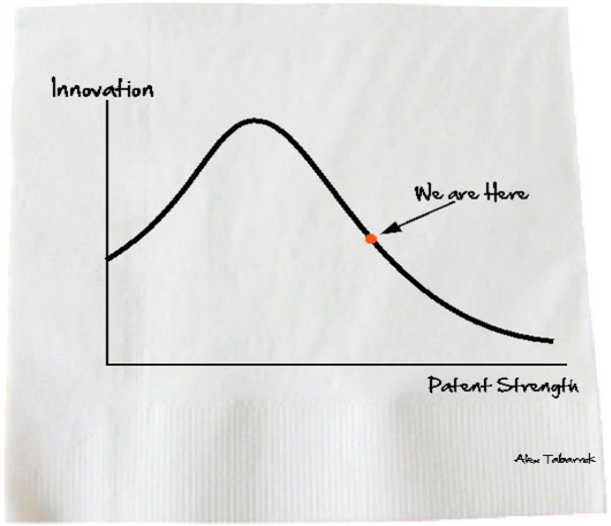
14 https://en.wikipedia.org/wiki/Leibniz%E2%80%93Newton_calculus_controversy

15 Burton, M. D., & Nicholas, T. (2017). Prizes, patents and the search for longitude. *Explorations in Economic History, 64*, 21-36.

16 Barnett, J. M. (2016). Three Quasi-Fallacies in the Conventional Understanding of Intellectual Property. *JL Econ. & Pol'y, 12*, 1.

rights may reduce it. If you draw this as a graph it's called the Tabarrok Curve.[17] And it may matter what our alternatives are. Even if patents work well, innovation prizes may work similarly with fewer drawbacks and restrictions on freedom. But the chief benefit of patents as opposed to other innovation-promoting government mechanisms is that it is a market mechanism for subsidising socially-beneficial inflation. Most patents end up being worthless to those who take them out. But the ones that contribute to social welfare—as measured by the market—are rewarded hugely.

A pragmatic free market approach to IP recognises that it may be a necessary evil—but it may not, and we might have too much or too little of it, or be doing it in the wrong ways. This is a question that has to be answered empirically. Though Boldrin and Levine disagree with me in their conclusions, their approach—historical evidence—is the right one.[18]



PAST & PRESENT

The British Statute of Monopolies gave us the world's first patent-awarding authority in 1624. It evolved from the much-abused previous letters patent system, which in turn evolved out of a common law patent system. The system was always controversial, and the arguments used historically are barely different than those used today. Indeed, proponents of free enterprise have always been chief among its opponents.[19]

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17 https://www.forbes.com/sites/timworstall/2013/06/23/the-tabarrok-curve-why-the-patent-system-is-not-fit-for-purpose/#47e274505d25

18 Boldrin, M. (2009). Against intellectual monopoly. *Syracuse Sci. & Tech. L. Rep., 2009*, 130-130.

19 Machlup, F., & Penrose, E. (1950). The patent controversy in the nineteenth century. The Journal of Economic History, 10(1), 1-29.

Measuring the effects of patents can be difficult.[20] One study looks at 1,012 major inventions as recorded in a 1954 history book, with a smaller set of 115 major breakthroughs in a 2007 encyclopaedia as a backup: it finds even among these that stricter patents leads to more innovation.[21] Conflicting evidence abounds. But the opponents of intellectual property make arguments closely analogous to the opponents of property itself. Zorina Khan, a professor at Bowdoin College and fellow at Stanford University's free market Hoover Institution, has relentlessly catalogued these in empirical work.

In one of her papers she details numerous massive legal battles over intellectual property in US economic history, noting a bump at the introduction of transformative technologies like railroads, the wireless, and telephones.[22] This is closely analogous to adjudicating claims over land rights in virgin territory: society bears costs in dividing up claims until recognised claims are all decided upon and a matter of common knowledge.

NON-PRACTISING ENTITIES IN HISTORY

She also shows how, relative to history, patent litigation is fairly restrained, and how non-practicing entities (NPE hereafter) have always been a significant section of the market.[23] [24] Indeed, she shows how NPEs—organisations which did not make or exploit technological discoveries, but merely bought the rights to and licensed them—have always been a feature of the market.[25] Just as the division of labour and specialisation identified first by Adam Smith help every other market, so they do in legal enforcement. In fact, it was especially the great inventors, and inventors from marginalised groups or of humble background, that typically sold off their inventions for exploitation by others.[26]

Critics allege that the existence and prevalence of NPEs itself implies that patents have slipped from financing and driving innovation to holding it up with meretricious and vexatious litigation. But empirical work suggests that patent generators assign their rights to these specialist "trolls" because they are indeed better placed to protect their rights.[27] Indeed, some evidence suggests that the credibility of "trolls" is such that patent transfers to NPE actually reduce litigation. [28] Unsuccessful litigation can bankrupt an individual. Through diverse holdings and scale

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20 Ouellette, L. L. (2015). Patent experimentalism. *Virginia Law Review,* 65-128.

21 Chen, Qiang. (2008) "The effect of patent laws on invention rates: Evidence from cross-country panels." *Journal of Comparative Economics* 36.4 : 694-704.

22 Khan, B. Z. (2013). Trolls and other patent inventions: economic history and the patent controversy in the twenty-first century. *Geo. Mason L. Rev.*, 21, 825.

23 Lemley, M. A., & Shapiro, C. (2005). Probabilistic patents. *The Journal of Economic Perspectives, 19*(2), 75-98.

24 Risch, M. (2012). Patent Troll Myths. *Seton Hall L. Rev.,* 42, 457.

25 Bottomley, S. Patents and the first industrial revolution in the US, France and Britain, 1700-1850.

26 Khan, B. Z. (2005). *The Democratization of Invention: patents and copyrights in American economic development*, 1790-1920. Cambridge University Press.

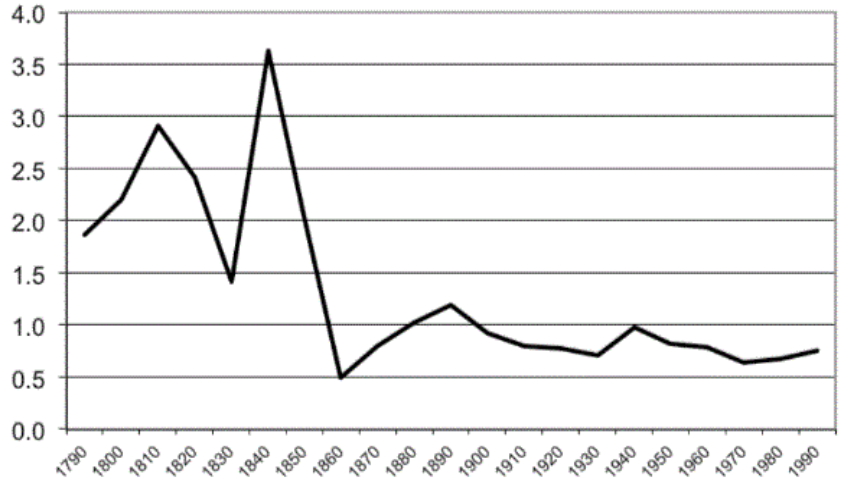
27 Haber, S., & Werfel, S. H. (2015). *Why Do Inventors Sell to Patent Trolls? Experimental Evidence for the Asymmetry Hypothesis*. Stanford University Working Paper.

28 Galasso, A., Schankerman, M., & Serrano, C. J. (2013). Trading and enforcing patent rights. *The RAND Journal of Economics, 44*(2), 275-312.

patent assertion entities can credibly assert their patents in a way that individual inventors cannot, curiously mirroring the alienable litigation rights held in libertarian medieval Iceland.[29] [30] Indeed, trolls seem to litigate on the back of especially high quality patents.[31] There is, however, some evidence that smaller firms find it hard to license and follow on from innovation initiated by larger firms.[32]

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 published volumes of reports of patent cases. Patent grants were obtained from annual reports of the U.S. Patent Office. *See, e.g.*, U. S. PATENT & TRADEMARK OFFICE, *supra* note accompanying Figure 1, at 192 (data set on file with author).

Source: Khan, B. Z. (2013). Trolls and other patent inventions: economic history and the patent controversy in the twenty-first century. Geo. Mason L. Rev., 21, 825.

This diverse market of patent agents and lawyers provided the framework that allowed independent inventors to spend their time inventing, not marketing and exploiting their work.[33] It was very clear that the ability to patent their discoveries was a key enabler and driver of their specialisation.[34] Without patents, firms must vertically integrate invention within their business structure to make exploiting technological discovery viable; clear property rights institutions make Smithian

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29 Friedman, D. (1979). Private creation and enforcement of law: a historical case. *The Journal of Legal Studies*, 8(2), 399-415.

30 Kerekes, C. B., & Williamson, C. R. (2012). Discovering law: Hayekian competition in medieval Iceland. *Griffith Law Review*, 21(2), 432-447.

31 Fischer, T., & Henkel, J. (2012). Patent trolls on markets for technology–An empirical analysis of NPEs' patent acquisitions. *Research Policy, 41*(9), 1519-1533.

32 Galasso, A., & Schankerman, M. (2014). Patents and cumulative innovation: Causal evidence from the courts. *The Quarterly Journal of Economics, 130*(1), 317-369.

33 Lamoreaux, N. R., & Sokoloff, K. L. (2001). Market trade in patents and the rise of a class of specialized inventors in the 19th-century United States. *The American Economic Review, 91*(2), 39-44.

34 Lamoreaux, N. R., & Sokoloff, K. L. (1996). Long-term change in the organization of inventive activity. *Proceedings of the National Academy of Sciences, 93*(23), 12686-12692.

divisions of labour between inventors and firms possible—they create a market for technology.[35]

THE MARKET FOR IDEAS

Without patents it is very difficult to establish such a "market for ideas".[36] [37] Unlike with concrete physical things, divulging an idea is tantamount to giving it away. If the courts would enforce them, there might be feasible ways of contracting this away, as with non-disclosure agreements. But the transactions costs could be large: there need to be millions of interactions over potential licensing, cross-licensing, combining, improving and so on—and detailed contracts would have to be written, vetted, and signed even before potential deals could be described.[38] [39] Consider a smartphone, where thousands of innovations from individual inventors are combined together into one final product.[40]

Imagine that describing your house brought a high risk of it transferring into the ownership of someone else.[41] Many fewer transactions would occur, and houses would stay in the hands of those who value them less. We know from the impact of stamp duty on conveyances that this has gigantic efficiency costs.[42] Similarly efficiency is hit by ideas being stuck in the minds and knowledge of those less suited to profit from exploiting them.

In fact, even with the existence of patents manufacturing firms do not apply for them, instead using secrecy and lead-time to protect their ideas instead—since sufficiently differentiated imitations that do not violate their patents are often viable.[43] Similarly, temporarily abolishing patents in the Netherlands in 1869 shifted industrial effort into secrecy-heavy industries like food processing.[44]

One case where there is a functioning market for ideas is university patents: the higher quality patents are more likely to be sold off to business to exploit; and even controlling for patent characteristics a patent is more rapidly and extensively cited than one kept within a university.[45] Another is semiconductors, where over the past

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35 Kuhn, J. M. (2016). Property Rights and Frictions in the Sale of Patents.

36 Spulber, D. F. (2015). How patents provide the foundation of the market for inventions. *Journal of Competition Law & Economics, 11*(2), 271-316.

37 Dushnitsky, G., & Klueter, T. (2011). Is there an eBay for ideas? Insights from online knowledge marketplaces. European Management Review, 8(1), 17-32.

38 Arqué-Castells, P., & Spulber, D. F. (2017). Firm Matching in the Market for Technology.

39 Yanagisawa, T., & Guellec, D. (2009). The emerging patent marketplace. OECD Science, *Technology and Industry Working Papers, 2009*(9), 0_1.

40 Spulber, D. F. (2016). Patent licensing and bargaining with innovative complements and substitutes. *Research in Economics, 70*(4), 693-713.

41 Arrow, K. (1962). Economic welfare and the allocation of resources for invention. In *The rate and direction of inventive activity: Economic and social factors* (pp. 609-626). Princeton University Press.

42 Southwood, B. (2017) *Stamp Duty Land Tax.* Adam Smith Institute

43 Cohen, W. M., Nelson, R. R., & Walsh, J. P. (2000). *Protecting their intellectual assets: Appropriability conditions and why US manufacturing firms patent (or not)* (No. w7552). National Bureau of Economic Research.

44 Nicholas, T. (2014). Are patents creative or destructive?. *Antitrust Law Journal, 79*(2), 405.

45 Sterzi, V. (2013). Patent quality and ownership: An analysis of UK faculty patenting. *Research Policy, 42*(2), 564-576.

two decades firms have dis-integrated: separating into "fabless" firms that design microchips and "foundries" that produce them.[46] A third example is Germany, where patents are most extensively used in collaborative research.[47] This may all be impossible without patents that let firms get to the table without having ideas expropriated.

If inventors could not protect their ideas it would also be much harder to get finance or investment. They would either have to finance any expansion themselves, or sign complex non disclosure agreements even before meeting with any investors or financiers. In fact patents seem to be a crucial way that innovators secure investment.[48] Walter Hunt, who invented the safety pin, is a classic example: he sold his patent to W.R. Grace and Company for about $10,000 of today's dollars, who mass-produced it.[49] Cleveland during the second industrial revolution provides a more general illustrative case study with small inventors securing investment to develop technologies by patenting their innovations.[50] And there is a clear link between the secondary patent market and startups empirically: more patent trading is linked with more startup funding from venture capitalists.[51] [52]

Recent US data bears this idea of a thriving patent market out more generally:

> *First, somewhere between 15 and 20% of patents are sold. Second, it takes on average 5.48 years to sell a patent. Third, a firm's patent stock contributes more to its market value the closer it is to the firm in terms of average technological distance. Fourth, a patent is more likely to be sold the more distant it is to a firm's line of business. Fifth, when a patent is sold it is closer to the buyer's line of business than to the seller's. The empirical analysis attempts to control for licensing and litigation. These five facts suggest that a market for patents may play an important role in correcting the misallocation of ideas across firms.*[53]

Of course, the existence of many other established claims—or potential claims—over ideas in a field will stall new entrants to that field.[54] But it's hard to see how patents are any different to other patterns of legal rights. Opponents of market mechanisms for organising economic activity have always argued that individuals

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46 Barnett, J. M. (2010). Intellectual property as a law of organization. *S. Cal. L. Rev.*, 84, 785.

47 Crass, D., Garcia-Valero, F., Pitton, F., & Rammer, C. (2016). Protecting innovation through patents and trade secrets: Determinants and performance impacts for firms with a single innovation.

48 Häussler, C., Harhoff, D., & Müller, E. (2012). To Be Financed or Not…-The Role of Patents for Venture Capital-Financing.

49 Akcigit, U., Celik, M. A., & Greenwood, J. (2016). Buy, keep, or sell: Economic growth and the market for ideas. *Econometrica, 84*(3), 943-984.

50 Lamoreaux, N. R., Levenstein, M., & Sokoloff, K. L. (2006). Mobilizing venture capital during the second industrial revolution: Cleveland, Ohio, 1870-1920. *Capitalism and Society, 1*(3).

51 Hochberg, Y. V., Serrano, C. J., & Ziedonis, R. H. (2014). *Patent collateral, investor commitment, and the market for venture lending* (No. w20587). National Bureau of Economic Research.

52 Farre-Mensa, J., Hegde, D., & Ljungqvist, A. (2016). *The bright side of patents* (No. w21959). National Bureau of Economic Research.

53 Häussler, C., Harhoff, D., & Müller, E. (2012)

54 Cockburn, I. M., & MacGarvie, M. J. (2009). Patents, Thickets and the Financing of Early-Stage Firms: Evidence from the Software Industry. *Journal of Economics & Management Strategy, 18*(3), 729-773.

will find it difficult to bring economic order when so many complex multilateral agreements are needed to coordinate different actors and their rights. Patterns of small landholders, they argue, constitute "land thickets" and only compulsory purchase orders (aka eminent domain) can rationalise them when large projects require consent from many. But the ability of selfish decentralised actors to create an efficient rational order is a key part of economics, from Adam Smith's butcher and baker to mainstream economics textbooks today.[55] [56] The success courts experienced in dealing with overlapping radio patents in the period 1905-20 is one example.[57]

In fact, one major function of internal research & development labs is to interpret, understand, and validate the import of externally developed tech.[58] Even in the 1920s-1950s, an era of massive vertically integrated firms, many of the most valuable patents firms got hold of came from outside.[59] [60] [61] These markets for technology have returned in the era of tech startups and venture capital.[62]

ROYALTY STACKING AND SMARTPHONES

One modern example is smartphones. In order to develop a smartphone you must license hundreds or thousands of technologies from dozens of different inventors, firms, and rightsholders. Lacking a license to even one of these standard-setting patents individual could plausibly doom your attempt. So one suggestion is that startups may end up paying excessive royalties since all the diverse patent holders have independent monopolies—this is known as royalty stacking. Patent reformers suggest this problem is a tragedy of the anti-commons.

But, empirically, this does not seem to hold up in smartphones.[63] [64] There are 21 main pools of patent licensors; which according to the seminal royalty stacking model would predict a 79% royalty yield—that is, around four fifths of every £1 paid for a smartphone goes to patent holders of some type.[65] But in fact around 3%

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55 Varian, H. R. H. R. (1987). *Intermediate Microeconomics*; a modern approach(No. 04; HB172, V3y.).

56 Harper, D. A. (2015). Intellectual property as a complex adaptive system. In *The Evolution of Economic and Innovation Systems* (pp. 309-339). Springer International Publishing.

57 Howells, J. (2014). The Coordination of Independently-Owned Vacuum Tube Patents in the Early Radio Alleged Patent "Thicket". In *Symposium on History of Patented Innovation*.

58 Mowery, D. C., & Oxley, J. E. (1995). Inward technology transfer and competitiveness: the role of national innovation systems. *Cambridge journal of economics, 19*(1), 67-93.

59 Nicholas, T. (2003). Why Schumpeter was right: innovation, market power, and creative destruction in 1920s America. *The Journal of Economic History, 63*(4), 1023-1058.

60 Hintz, E. S. (2007, January). Independent Inventors in an Era of Burgeoning Research & Development. In *Business History Conference. Business and Economic History On-line: Papers Presented at the BHC Annual Meeting(Vol. 5, p. 1).* Business History Conference.

61 Nicholas, T. (2011). Independent invention during the rise of the corporate economy in Britain and Japan. *The Economic History Review, 64*(3), 995-1023.

62 Arora, A., Fosfuri, A., & Gambardella, A. (2004). *Markets for technology: The economics of innovation and corporate strategy*. MIT press.

63 Galetovic, A., Haber, S., & Zaretzki, L. (2017). Is There an Anti-commons Tragedy in the Smartphone Industry?.

64 Siebrasse, N. (2017). Holdup, Holdout and Royalty Stacking: A Review of the Literature.

65 Lemley, M. A., & Shapiro, C. (2006). Patent holdup and royalty stacking. *Tex. L. Rev.*, 85, 1991.

does. This suggests markets are able, as in other sectors, of coordinating complex and diverse individuals.

This worry about royalty stacking and patent thickets would also imply that the sectors with the most patents granted would be stuck in the doldrums, or at least growing slower than others. But it is precisely those industries with dispersed patent holders and fast rates of new patents that show the fastest growth, falling prices and new products—principally technology.[66] In the words of Galetovic, Haber, and Levine, "if patent holdup is slowing innovation, it is slowing it down to perhaps the fastest rate in history."[67]

Similarly, critics allege that intellectual property destroys value through duplication of efforts. Often more than one firm will work on developing a technology at the same time—one survey found this was the case for about 10% of patented innovations.[68] But this "duplication" is a normal feature of other markets. Many firms—Yahoo, Ask Jeeves, Bing (Microsoft), and Alta Vista vied for the search market while Google was establishing dominance. Is it wasteful duplication if car firms lose money as they try and dominate the automobile market? Normal features of markets are often judged insurmountable when it comes to IP. But in fact markets resolve coordination problems surprisingly well.[69] [70]

ALTERNATIVE WAYS OF FINANCING & INCENTIVISING INNOVATION

It is clear from history that the patent system is not out of control, and that any problems it has are problems similar to any decentralised system with actors pursuing many divergent interests. There is a clear mechanism by which patents stimulate sharing innovation, and allow a market for ideas—similar innovation may go on without patents, but the need to keep secrets prevents diversification and trade. Without patents, firms are incentivised to become large vertically integrated conglomerates.

But societies have experimented with other means of incentivising productive discovery, principally offering prizes to those who could solve some specified social or technological problem. It's easy to see why some would be drawn to prizes: unlike property rights they do not allow anyone to exclude users of an original idea, so in principle their use can spread rapidly straight away. However, they have fundamental drawbacks, even in principle.

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66 Barnett, J. (2017). Has the Academy Led Patent Law Astray?.

67 Galetovic, A., Haber, S., & Levine, R. (2014). Patent Holdup: Do Patent Holders Holdup Innovation?. *Hoover Institution Working Group on Intellectual Property, Innovation, and Prosperity. Stanford University Working Paper Series,* (14011).

68 Thompson, N., & Kuhn, J. M. (2017). Does Winning a Patent Race lead to more follow-on Innovation?.

69 Coase, R. H. (2013). The problem of social cost. The journal of Law and Economics, 56(4), 837-877.

70 Coase, R. H. (1937). The nature of the firm. economica, 4(16), 386-405.

Figure 1

		Reward Setting	
		Government-Set	Market-Set
Reward Timing	*Ex Ante*	Grants	R&D tax credits
	Ex Post	Longitude-type prizes	Patents (also: patent boxes)

Alternatives to patents exist and are well established. Society can give publicly funded grants, in advance of research success, which is often used for research believed to be "basic".

They can allow firms to deduct research and development costs against tax, again prior to result and which uses the market to direct activity, but essentially achieves the same goal.[71]

The other alternative, that guarantees success by rewarding after the event is a prize. A clever prize need not be excessively narrow. For example, instead of offering a prize to those who can make an engine for a Ford Focus that gets 100mpg in normal driving, they could offer the same reward for a more broadly drawn set of goals: not specifying petrol, a Ford Focus, that the efficiency comes through the engine and so on. But prizes still rely on the assumption we have foreknowledge of the most productive inventions: that we can decide in advance which innovations will help society the most. They also assume we can work out how much some advance is worth.[72]

This is not to say prizes don't work. Economic history research provides some evidence that they did. Liam Brunt, Josh Lerner and Tom Nicholas looked at Royal Agricultural Society of England prizes between 1839 and 1939 and found that both pecuniary and non-pecuniary awards were highly effective drivers of research.[73] Prizes, through the publicity they give, may also promote research in especially promising areas—Crystal Palace exhibitors in 1851 saw far more citations to their US patents if they'd won an award.[74] But many patentees, award winners or not, used exhibitions like Crystal Palace, Philadelphia in 1876, and Turin in 1911 to market their ideas.[75]

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71 Hemel, D. J., & Ouellette, L. L. (2013). Beyond the Patents-Prizes Debate. *Texas Law Review, 92*(2), 303.

72 Murray, F., Stern, S., Campbell, G., & MacCormack, A. (2012). Grand Innovation Prizes: A theoretical, normative, and empirical evaluation. *Research Policy, 41*(10), 1779-1792.

73 Brunt, L., Lerner, J., & Nicholas, T. (2012). Inducement prizes and innovation. *The Journal of Industrial Economics, 60*(4), 657-696.

74 Moser, P., & Nicholas, T. (2013). Prizes, Publicity and Patents: Non - Monetary Awards as a Mechanism to Encourage Innovation. *The Journal of Industrial Economics, 61*(3), 763-788.

75 Domini, G. (2016). Patents, exhibitions and markets for innovation in the early twentieth century: Evidence from Turin 1911 International Exhibition. *THE ECONOMIC HISTORY SOCIETY*, 79.

By contrast, patents are agnostic and decentralised. The vast majorities of patents never earn their holders a penny. A small number make their inventors or holders very rich because compared to close substitutes, the products they enable are much better; so much better that consumers earn extra surplus, producers earn extra surplus, and patent holders earn rents—all at the same time. The market rewards inventions after the fact in direct proportion to how much they make people's lives better, as with any other business decision.[76]

PRICES VERSUS PRIZES

But according to a wealth of research comparing prizes with patents, they have exactly the drawbacks our experience would suggest: narrow incentivisation works for solving narrow problems; but it is not the optimal way of servicing consumer preferences and thereby advancing social progress in general.

One example is the annual industrial fairs in 19th century Massachusetts. Relative to patents awarded over the same time period prizes were mainly used for advertising purposes, were awarded unsystematically and unpredictably, and did not vary in line with how useful or popular an invention or innovation ended up being.[77] What's more, prizewinners were typically from a more privileged class than patentees. This all implies that patents are more market driven and better at incentivising creative innovation, author B Zorina Khan says.

Another piece of evidence looks at similar data—American Institute of New York annual fairs—from a different angle. As we have seen in the debate around follow-on innovation, one argument against patents is that they limit what others can do on top of a given innovation, or how much they can be inspired by a particular breakthrough, because they might have to license the patent or risk infringing it. One argument in the other direction is that patents allow people to bring their information out into the open because others will not use it to jump ahead, so it encourages openness. What's more, all of their info surrounding the innovation is written down and easy to find.

Khan finds that the second effect predominates; patents encourage 'spillover' innovation more than prizes:

> *In keeping with the contract theory of patents, the procedure identifies high and statistically significant spatial autocorrelation in the sample of inventions that were patented, indicating the prevalence of geographical spillovers. By contrast, prize innovations were much less likely to be spatially dependent. The second part of the paper investigates whether unpatented innovations in a county were affected by patenting in contiguous or adjacent counties, and the analysis indicates that such spatial effects were large and significant. These results are consistent with the argument that patents enhance the diffusion of information for both patented and unpatented innovations, whereas prizes are less effective in generating external*

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76 Friedman, J. (2007). There is no substitute for profit and loss. *Society, 44*(3), 48-53.

77 Khan, B. Z. (2014). *Of Time and Space: Technological Spillovers among Patents and Unpatented Innovations during Early US Industrialization (No. w20732)*. National Bureau of Economic Research.

> *benefits from knowledge spillovers. I hypothesize that the difference partly owes to the design of patent institutions, which explicitly incorporate mechanisms for systematic recording, access, and dispersion of technical information.*

Khan and collaborator Kenneth Sokoloff also go through 400 inventors all born before 1886 and listed in the Dictionary of American Biography, looking at 4,500 of the 16,900 patents they amassed between them.[78] They found that the so-called "great inventors" were highly procyclical—inventing more when the economy booms, and less when hit by busts or wars. Great inventors were especially likely to patent and to try and exploit those patents for material gain, relative to regular inventors. They clustered in areas with links to transport and to the institutions of intellectual property protection. The inventors were mostly from modest backgrounds, unlike the aristocratic tinkerers of Britain's first industrial revolution; many worked from an early age or had little formal education. All of these suggest that the incentive mechanism was working.

British prize systems, through the Royal Society of the Arts from its founding in 1754, were often motivated by mercantilist doctrine and jingoism—favouring replicating foreign inventions rather than importing them and focusing on other areas.[79] [80]

Though it was not as extensive as prize systems suggested by Bernie Sanders or other American prize advocates, the Soviet Union, as well as funding research directly, used a prize system to incentivise innovation.[81] Obviously comparing the US and USSR is difficult, but it seems like the Soviets were far behind the West in technology, despite extensive espionage.[82] This is indicated by many CIA reports, its slow productivity growth, and poor living standards.

The case for prices, versus prizes, is the case for markets versus planning in general. A patent is a prize whose value varies with the value of that asset to society.[83]

A SELECTION OF RECENT EVIDENCE

Testing the impact of the patent system on total innovation is very difficult. Like in most of economics, there are no true randomised controlled trials, and identifying causality between variables in a complex system like a whole economy is extremely difficult.

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78 Khan, B. Z., & Sokoloff, K. L. (2004). *Institutions and Technological Innovation During the Early Economic Growth: Evidence from the Great Inventors of the United States, 1790-1930 (No. w10966).* National Bureau of Economic Research.

79 Khan, B. Z. (2015). Inventing Prizes: A Historical Perspective on Innovation Awards and Technology Policy. Business History Review, 89(4), 631-660.

80 Khan, B. Z. (2017). Prestige and Profit: The Royal Society of Arts and Incentives for Innovation, 1750-1850 (No. w23042). National Bureau of Economic Research.

81 Arrow, K. (1962).

82 Glitz, A., & Meyersson, E. (2017). Industrial Espionage and Productivity (No. 10816). Institute for the Study of Labor (IZA).

83 Spulber, D. F. (2014). Prices versus prizes: Patents, public policy, and the market for inventions.

The true effect of a different sort of system comes only in the long run: technologies often ripple through the economy only slowly, and it often takes time to work out all the ways in which an innovation can be exploited. What's more, there may be "nonlinearities" in how patents affect the economy: perhaps some patent protection boosts innovation a lot, but past a certain point it has no effect or even a negative effect. Identifying counterfactuals is difficult because we don't know how much innovation there could have been at any given time. And even measuring and quantifying innovation is itself difficult: we could of course use patents and patent citations—but the incentive to patent, as well as the incentive to innovate, is affected by the IP regime.

An early literature depended on survey evidence: asking samples of firms whether they thought patents were necessary to invention. Firms typically thought that a substantial fraction of, but by no means all, innovations had relied on patents to come about, especially in certain industries (e.g. pharmaceuticals and chemicals).[84] [85] [86] But as economists gained access to more data and better technology they started applying more sophisticated empirical methods to the question.

One study exploits a change in Japanese patent law that widened the scope of the rights they awarded in 1988.[87] They look at the R&D done by 300 large public Japanese firms and find little deviation in the trend with broader rights. Another study looks at whether foreign firms patent more in some other country (in practice Britain) when patent rights at home strengthen.[88] If patent rights stimulated innovation then we'd expect (the author argued) that firms would have more ideas to patent abroad—but there was little effect here either.

But other studies, of India and Taiwan, for example, have found contrasting results, even with similar methodologies.[89] [90] And further studies also find the opposite result: stronger patenting at home leads to more exporting and licensing abroad.[91] Stronger rights globally are associated with more R&D.[92] And more patenting, es-

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84 Mansfield, E. (1986). Patents and innovation: an empirical study. *Management science, 32*(2), 173-181.

85 Levin, R. C., Klevorick, A. K., Nelson, R. R., Winter, S. G., Gilbert, R., & Griliches, Z. (1987). Appropriating the returns from industrial research and development. *Brookings papers on economic activity, 1987*(3), 783-831.

86 Cohen, W. M., Nelson, R. R., & Walsh, J. P. (2000). *Protecting their intellectual assets: Appropriability conditions and why US manufacturing firms patent (or not)* (No. w7552). National Bureau of Economic Research.

87 Sakakibara, M. & Branstetter, L. (2001). Do stronger patents induce more innovation? Evidence from the 1998 Japanese patent law reforms. *RAND Journal of Economics*. *32* (1), 77–100

88 Lerner, J. (2009). The empirical impact of intellectual property rights on innovation: Puzzles and clues. *The American Economic Review, 99*(2), 343-348.

89 Lo, S. T. (2011). Strengthening intellectual property rights: Experience from the 1986 Taiwanese patent reforms. *International Journal of Industrial Organization, 29*(5), 524-536.

90 Jagadeesh, H., & Sasidharan, S. (2014). Do stronger IPR regimes influence R&D efforts? Evidence from the Indian pharmaceutical industry. *Global Business Review, 15*(2), 189-204.

91 Briggs, K., & Park, W. G. (2014). There will be exports and licensing: The effects of patent rights and innovation on firm sales. *The Journal of International Trade & Economic Development, 23*(8), 1112-1144.

92 Kanwar, S., & Evenson, R. (2003). Does intellectual property protection spur technological change?. *Oxford Economic Papers, 55*(2), 235-264.

pecially of higher quality patents, has been associated with concomitant and following economic growth.[93] It is especially associated with growth in patent-intensive manufacturing industries.[94]

And reforms bringing developing countries more extensive patents seemed to boost technology transfer there by multinationals, even in highly disaggregated data looking at specific products, at the same time boosting industrial activity.[95] [96] What's more, this did not come from reduced imitation or mere formalisation of activity that was already going on.

But these studies, on both sides, are by no means conclusive, and admit of multiple explanations. For example, expansions of patent law in one country also induce foreign innovation; a firm stands to gain from patenting in any market around the world—foreign patenting is no mere spillover. Narrower tests have tried to get around this problem and provide clearer answers.

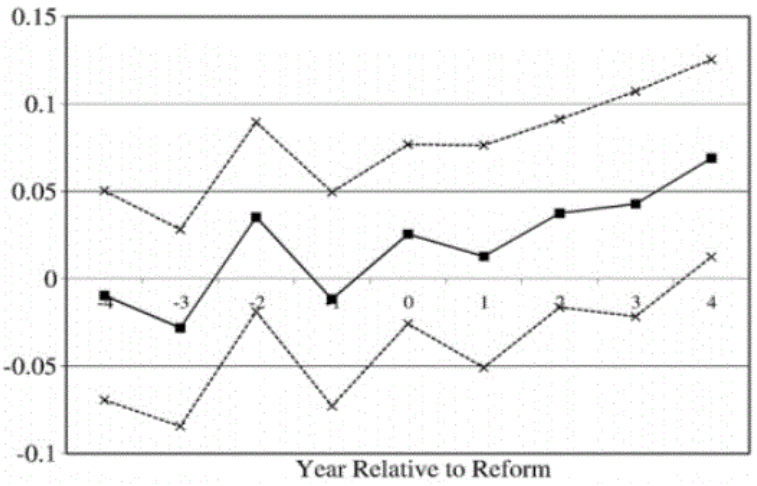

Fig. 2. This figure displays the dynamics of changes in affiliate size around the time of reform. The points are generated by regressing the log of affiliate assets on affiliate fixed effects, country–year fixed effects, the controls from the specifications in Table 2 that are not collinear with the fixed effects (namely the log of total parent system sales and the log of parent R&D), and a set of dummies that are equal to one in years relative to the IPR reform for affiliates that have a High Technology Transfer Dummy equal to one. The points are the coefficient estimates on these time-specific dummies for affiliates in the High Technology Transfer sample.

One study looks at pharmaceutical trial length. Gaining Food and Drug Administration approval is driven by proving effectiveness and safety.[97] But some conditions have their ill effects only slowly and others very quickly. This means that

93 Hasan, I., & Tucci, C. L. (2010). The innovation–economic growth nexus: Global evidence. *Research Policy, 39*(10), 1264-1276.

94 Hu, A. G., & Png, I. P. (2013). Patent rights and economic growth: evidence from cross-country panels of manufacturing industries. *Oxford Economic Papers, 65*(3), 675-698.

95 Branstetter, L., Fisman, R., Foley, C. F., & Saggi, K. (2011). Does intellectual property rights reform spur industrial development?. *Journal of International Economics, 83*(1), 27-36.

96 Kyle, M., & Qian, Y. (2014). *Intellectual property rights and access to innovation: evidence from TRIPS (No. w20799)*. National Bureau of Economic Research.

97 Budish, E., Roin, B. N., & Williams, H. (2015). Do firms underinvest in long-term research? Evidence from cancer clinical trials. *The American economic review, 105*(7), 2044-2085.

proving effectiveness against some conditions takes far longer than for others—it takes a while to rule out sheer randomness—and by the time this is proved, some of the years of the patent are already gone. As expected, cancers which take longer to metastasize show far less investment from firms, consistent with patenting incentives driving investment.

FOLLOW-ON INNOVATION

If patents lead to more "original" innovation, then it may be worth some decline in follow-on innovation, but as we've seen the effect on subsequent inventions is theoretically ambiguous. Patents may increase follow-on innovation through disclosure, or decrease it through their monopoly/exclusivity effect—and this effect may not matter if licensing is prevalent. Survey and econometric evidence has attempted to address the question empirically.

The survey evidence is inconclusive. Some suggests that innovators learn from the stock of patents, and new patents coming into force.[98] Some suggests they ignore them.[99] Some suggests that they find it easy to get around them with licensing and working solutions.[100]

One more innovative approach looks at invalidated patents.[101] Those who build on invalidated patents must cite them as if they were valid, but they are more free to build cumulatively on their work. In their evidence, invalidation boosts citations to the relevant patent around 50%. But it seems like this approach admits of multiple explanations. Invalidation could raise awareness of a given finding. If there is ambiguity in patent court cases, citing an invalid patent could also provide a salient "excuse" for some possible infringement in a new product or technology. What's more, in this example a patent already exists, and so the function of disclosure has already occurred—it is really testing a shorter patent term rather than no patents at all. There's a further problem––inventors do not know in advance that their patent will be invalidated. But if they did know in advance then they will be less likely to invent in the first place. As a result, studies looking at invalidated patents cannot prove that patents impede follow-on innovation, rather they can only prove that expanding the public domain enables follow-on innovation.

A second study looks at patents on human genes—though there is more innovation around DNA sequences that are patented, this is also true *before* they are patented.[102]The authors look at the assignment of patent claims to lenient or strict examiners—strict examiners result in more delay to a patent being granted, and in this study there is no difference. Innovation in a given gene area looks similar when that

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98 Ouellette, L. L. (2011). Do Patents Disclose Useful Information. *Harv. JL & Tech.*, 25, 545.

99 Walsh, J. P., Cohen, W. M., & Cho, C. (2007). Where excludability matters: Material versus intellectual property in academic biomedical research. *Research Policy, 36*(8), 1184-1203.

100 Walsh, J. P., Arora, A., & Cohen, W. M. (2003). Working through the patent problem. *Science, 299*(5609), 1021.

101 Galasso, A., & Schankerman, M. (2014). Patents and cumulative innovation: Causal evidence from the courts. *The Quarterly Journal of Economics, 130*(1), 317-369.

102 Sampat, B., & Williams, H. L. (2015). *How do patents affect follow-on innovation? Evidence from the human genome (No. w21666).* National Bureau of Economic Research.

area is patented rapidly and when it is patented later, implying quasi-experiments like the invalidation example, or other research on gene patents may show a representative effect.[103] [104]

Another way of looking at the effects of patents on follow-on innovation is looking at standard-essential patents. In some fields certain patents are essential to competition within the field. These are "standard-essential patents"—in order to make your device or item interoperable with other products in the field you must license a particular patent. If patent hold-up is significant these patents would be expected to have especially deleterious effects on follow-on innovation, since there is almost no way around them, unlike in other fields, where close substitutes may exist. But a study using several datasets and multiple metrics found that SEP-reliant industries typically had equal or faster quality-adjusted price declines than other patent-intensive industries.[105] And US reforms that cut SEP strength had no effects on the declines. What's more, these fields also saw more rapid output growth and more creative destruction—firm entry and exit—everything we'd expect in particularly dynamic, competitive markets.[106]

Overall, the empirical evidence in both areas is still weak and inconclusive, though it is consistent with, and indeed hints towards, a significant effect of patents on innovation, especially its spread and commercialisation.[107]

HOW CAN WE IMPROVE?

If patent protection boosts innovation, it does it because it awards firms economic rents for delivering new products or services that consumers want more than their closest substitutes. But patent protection may not be equally beneficial in all environments. And more patent protection is not always beneficial for innovation. For example, increasing the length of patents to 1,000 years would only slightly increase the incentives to investment, given normal discount rates, but it would drastically slow ideas' flows into the public domain. Though it seems clear that a patent system overall is a pragmatic market institution for incentivising, organising, and allocating innovation, this does not imply we cannot improve on the institutions we have.

- Some evidence suggests that countries with less product market regulation—things like licenses on who can make things, restrictions on what materials

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103 Murray, F., Aghion, P., Dewatripont, M., Kolev, J., & Stern, S. (2016). Of mice and academics: Examining the effect of openness on innovation. *American Economic Journal: Economic Policy, 8*(1), 212-252.

104 Williams, H. L. (2013). Intellectual property rights and innovation: Evidence from the human genome. *Journal of Political Economy, 121*(1), 1-27.

105 Galetovic, A., Haber, S., & Levine, R. (2015). An Empirical Examination of Patent Holdup. *Journal of Competition Law & Economics, 11*(3), 549-578.

106 Galetovic, A., & Haber, S. (2017). THE FALLACIES OF PATENT-HOLDUP THEORY. *Journal of Competition Law & Economics, 13*(1), 1-44.

107 Williams, H. L. (2017). *How Do Patents Affect Research Investments? (No. w23088)*. National Bureau of Economic Research.

products can or cannot contain, admin and form-filling, and price caps or minimums—and thus more product market competition, gain more from patents.[108] Pre-innovation, rents are low—firms are making normal profits—post-innovation they can potentially sweep up far more of the market than under a more dirigiste system.[109] [110]

- Similarly, evidence suggests that cutting patent fees may incentivise lower quality patents, or increase patenting without increasing innovation.[111] [112] Higher quality patents tend to see less litigation.[113]
- Countries with higher economic freedom and better education benefit from patent protection more—so in some cases it may be worth focusing on these first.[114] This seems especially driven by the strength of property rights in general.[115]
- Price regulation makes patents less effective, since it blunts the automatic market mechanisms generating dynamic efficiency with price signals.[116]
- Uncertain IP rights hinder collaboration, since they increase the risk that one's ideas will be appropriated by collaborators.[117]
- Incremental innovations that are only small improvements on existing drugs may allow firms to effectively extend patents far longer than intended, aka "evergreening", delaying the entry of generics for longer than is necessary to incentivise the original investment.[118]
- Software and business methods may be areas where patenting is not as valuable. Some evidence suggests they are valuable without showing the quality that other patents do, suggesting they are strategic.[119] The iterations are also smaller in these areas, with fewer large jumps, shifting the calculus.[120] But this

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108 Spulber, D. F. (2012). Competing inventors and the incentive to invent. *Industrial and Corporate Change, 22*(1), 33-72.

109 Aghion, P., Howitt, P., & Prantl, S. (2015). Patent rights, product market reforms, and innovation. *Journal of Economic Growth, 20*(3), 223-262.

110 Spulber, D. F. (2013). How do competitive pressures affect incentives to innovate when there is a market for inventions?. *Journal of Political Economy, 121*(6), 1007-1054.

111 Nicholas, T. (2011). Cheaper patents. *Research Policy, 40*(2), 325-339.

112 De Rassenfosse, G., & Jaffe, A. B. (2014). *Are patent fees effective at weeding out low-quality patents? (No. w20785)*. National Bureau of Economic Research.

113 Kiebzak, S., Rafert, G., & Tucker, C. E. (2016). The effect of patent litigation and patent assertion entities on entrepreneurial activity. *Research Policy, 45*(1), 218-231.

114 Qian, Y. (2007). Do national patent laws stimulate domestic innovation in a global patenting environment? A cross-country analysis of pharmaceutical patent protection, 1978–2002. *The Review of Economics and Statistics, 89*(3), 436-453.

115 Zhang, J., Du, D., & Park, W. G. (2015). How Private Property Protection Influences the Impact of Intellectual Property Rights on Economic Growth?. *Global Economic Review, 44*(1), 1-30.

116 Cockburn, I. M., Lanjouw, J. O., & Schankerman, M. (2016). Patents and the global diffusion of new drugs. *The American Economic Review, 106*(1), 136-164.

117 Czarnitzki, D., Hussinger, K., & Schneider, C. (2015). R&D collaboration with uncertain intellectual property rights. *Review of Industrial Organization, 46*(2), 183-204.

118 Yin, N. (2012). Pharmaceuticals, incremental innovation and market exclusivity. *Toulouse School.*

119 Hall, B. H., Thoma, G., & Torrisi, S. (2007, August). THE MARKET VALUE OF PATENTS AND R&D: EVIDENCE FROM EUROPEAN FIRMS. In *Academy of Management Proceedings* (Vol. 2007, No. 1, pp. 1-6). Academy of Management.

120 Hall, B. H., & MacGarvie, M. (2010). The private value of software patents. *Research Policy, 39*(7), 994-1009.

is uncertain: other evidence suggests the usual rules apply: patenting leads to collaboration, and also to more open source releases.[121] [122]

- Historically courts have sometimes offered patents that were overly broad, for example covering every version of a product, however independently generated or technically different.[123] The benefits from the incentive here are rarely large enough to outweigh the costs in terms of competing and cumulative innovation.

Tweaks along the lines of these findings could go some way to improving the patent system, but the crucial issue is not to throw the baby out with the bathwater. The patent system is broadly working in most developed countries. Restrictions to patents that are currently on the table are likely to reduce innovation. The problems that patents are suggested to have are problems that, if true, would apply to every sector of the economy—they would apply that decentralised actors and a price system could rarely or never coordinate on a rational economic order. But this seems obviously false, belied by history in every example.

CONCLUSION

Patents are an essential part of the intellectual property regimes of developed Western countries. Like the rest of the property rights in those countries, the precise contours of the system have been arrived at only after hundreds of years of common law evolution. The rules will continue to evolve.

But we should be careful before replacing litigation and the legal system with top-down regulation, or replacing large chunks of the system wholesale. The patent system, unlike any of the plausible alternatives, is a decentralised price system which tends towards dynamic efficiency by offering incentives in exact proportion to how much an invention, discovery, or innovation services consumer demand. None of its alternatives offer this feature.

Evidence from history and recent decades suggests patents are consistent with rapid intellectual progress. Indeed, they evolved in the most advanced countries and contemporaneously with spurts of innovation unprecedented in these countries' history. They are by no means the whole story. But histories that paint them as the villain can only do so by implying that the price system and markets as a whole are so heavily pervaded by failure as to be undesirable in all sectors.

Patents, broadly, work well. There are many issues in the system we should remain aware of. For example, the fact that patents work for chemicals and pharmaceuticals does not necessarily imply they work for software and business methods, and

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121 Fosfuri, A., Giarratana, M. S., & Luzzi, A. (2008). The penguin has entered the building: The commercialization of open source software products. *Organization science, 19*(2), 292-305.

122 Ceccagnoli, M., Forman, C., Huang, P., & Wu, D. J. (2012). Cocreation of value in a platform ecosystem: the case of enterprise software. *MIS Quarterly, 36*(1), 263-290.

123 Moser, P. (2016). Patents and Innovation in Economic History. *Annual Review of Economics, 8*, 241-258.

we should remain careful and willing to change especially in those areas. We should also bear in mind that patents work better when property rights in general are better protected and when markets are more competitive. And patents should not be excessively broad. But until something comes along that can beat property rights in general, they must be an essential part of our toolkit for promoting technological, intellectual, and social progress.