

The Case Against Patents

Author(s): Michele Boldrin and David K. Levine

Source: *The Journal of Economic Perspectives*, Vol. 27, No. 1 (Winter 2013), pp. 3-22

Published by: American Economic Association

Stable URL: <http://www.jstor.org/stable/41825459>

Accessed: 08-07-2016 20:49 UTC

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at
<http://about.jstor.org/terms>

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.



American Economic Association is collaborating with JSTOR to digitize, preserve and extend access to *The Journal of Economic Perspectives*

The Case Against Patents

Michele Boldrin and David K. Levine

The case against patents can be summarized briefly: there is no empirical evidence that they serve to increase innovation and productivity, unless productivity is identified with the number of patents awarded—which, as evidence shows, has no correlation with measured productivity. This disconnect is at the root of what is called the “patent puzzle”: in spite of the enormous increase in the number of patents and in the strength of their legal protection, the US economy has seen neither a dramatic acceleration in the rate of technological progress nor a major increase in the levels of research and development expenditure.

Both theory and evidence suggest that while patents can have a partial equilibrium effect of improving incentives to invent, the general equilibrium effect on innovation can be negative. 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. More generally, the initial eruption of innovations leading to the creation of a new industry—from chemicals to cars, from radio and television to personal computers and investment banking—is seldom, if ever, born out of patent protection and is instead the fruit of a competitive environment. It is only after the initial stage of rampant growth ends that mature industries turn toward the legal protection of patents, usually because their internal growth potential diminishes and they become more concentrated. These observations, supported by a steadily increasing body of evidence, are consistent with

■ *Michele Boldrin is Joseph Gibson Hoyt Distinguished University Professor of Economics and David K. Levine is John H. Biggs Distinguished University Professor of Economics, both at Washington University in St. Louis, Missouri. They are also both Research Fellows with the Federal Reserve Bank of St. Louis. Their email addresses are mboldrin@artsci.wustl.edu and david@dklevine.com.*

<http://dx.doi.org/10.1257/jep.27.1.3>

doi=10.1257/jep.27.1.3

theories of innovation emphasizing competition and first-mover advantage as the main drivers of innovation, and they directly contradict “Schumpeterian” theories postulating that government-granted monopolies are crucial to provide incentives for innovation. A properly designed patent system might serve to increase innovation at a certain time and place—and some patent systems, such as the late-nineteenth century German system allowing only process but not final product patents, have been associated with rapid innovation. Unfortunately, the political economy of government-operated patent systems indicates that such systems are susceptible to pressures that cause the ill effects of patents to grow over time. The political economy pressures tend to benefit those who own patents and are in a good position to lobby for stronger patent protection, but disadvantage current and future innovators as well as ultimate consumers. This explains why **the political demand for stronger patent protection comes from old and stagnant industries and firms, not from new and innovative ones**. Our preferred policy solution is to abolish patents entirely and to find other legislative instruments, less open to lobbying and rent seeking, to foster innovation when there is clear evidence that laissez-faire undersupplies it. However, if that policy change seems too large to swallow, we discuss in the conclusion a set of partial reforms that could be implemented as part of an incremental strategy of reducing the harm done by the patent system.

Do Patents Encourage Productivity Growth?

If there is to be any rationale for patent systems, with all their ancillary costs, it must be that they increase innovation and productivity. What is the evidence?

Simply eyeballing the big trends shows that patenting has exploded over the last decades. In 1983 in the United States, 59,715 patents were issued; by 2003, 189,597 patents were issued; and in 2010, 244,341 new patents were approved. In less than 30 years, the flow of patents more than quadrupled. By contrast, neither innovation nor research and development expenditure nor factor productivity have exhibited any particular upward trend. According to the Bureau of Labor Statistics, annual growth in total factor productivity in the decade 1970–1979 was about 1.2 percent, while in the decades 1990–1999 and 2000–2009 it has been a bit below 1 percent. Meanwhile, US research and development expenditure has been oscillating for more than three decades in a narrow band around 2.5 percent of GDP. The recent explosion of patents, in other words, has not brought about any additional surge in useful innovations and aggregate productivity. In new industries such as biotechnology and software—where innovation was already thriving in their absence—patents have been introduced without any positive impact on the rate of innovation. The software industry is an important case in point. In a dramatic example of judge-made law, software patents became possible for the first time in the early 1990s. Bessen and Meurer, in a large body of empirical work culminating in *Patent Failure* (2008), have studied the consequences of this experiment and have concluded that it damaged social welfare.

Academic studies have also typically failed to find much of a connection between patents and innovation. In Boldrin and Levine (2008b), we conducted a metastudy gathering the 24 studies (including three surveys of earlier empirical work) we could find in 2006 that examined whether introducing or strengthening patent protection leads to greater innovation. The executive summary states: “[T]hese studies find weak or no evidence that strengthening patent regimes increases innovation; they find evidence that strengthening the patent regime increases patenting! They also find evidence that, in countries with initially weak IP [intellectual property] regimes, strengthening IP increases the flow of foreign investment in sectors where patents are frequently used.” Actually, the issue of promoting foreign direct investment, while a well-established empirical consequence of strengthening patent regimes, is entirely beside the point of this essay. There are a number of ways to strengthen a country’s institutions and infrastructure in a way that would encourage foreign direct investment—and, in any case, foreign direct investment is not equivalent to innovation.

Our conclusion was in keeping with other studies that have addressed this question. Some studies have failed to find any connection even between changes in the strength of patent law and the amount of patenting, while others fail to find a connection between patents and some measure of innovation or productivity. For example, after failing to find a single study claiming that innovation increased as a consequence of the strengthening of US patent protection in the 1980s, Gallini (2002, p. 139) wrote in this journal: “Although it seems plausible that the strengthening of US patents may have contributed to the rise in patenting over the past decade and a half, the connection has proven difficult to verify.” Similarly, Jaffe (2000) also examines many studies and concludes: “[D]espite the significance of the policy changes and the wide availability of detailed data relating to patenting, robust conclusions regarding the empirical consequences for technological innovations of changes in patent policy are few. There is widespread unease that the costs of stronger patent protection may exceed the benefits. Both theoretical and, to a lesser extent, empirical research suggest this possibility.”¹

¹ The study by Kanwar and Evanson (2001) illustrates some of the issues that arise in these kinds of studies. They have two five-year averages on 31 countries for the period 1981–1990. They find support for the idea that higher patent protection leads to higher research and development spending as a fraction of GDP. However, a different story seems equally plausible. Countries with a larger market can more easily pay the fixed costs of innovation. Indeed, one perspective is that their data essentially compares countries with relatively small economies, little intellectual property protection, and low R&D spending with countries with relatively larger economies, greater intellectual property protection, and higher R&D spending. For example, R&D spending as a fraction of GDP in their data ranges from a ten-year average of 0.2 percent in Jordan to 2.8 percent in Sweden. If we combine their data with GDP data from *The 1990 CIA World Fact Book* to take account of the size of the economy, increasing the strength of intellectual property protection from 0 to 1 to 2 on their five-point scale does increase R&D expenditure. But as intellectual property protection is increased further, the gains to R&D expenditure levels then falls. Even at the lower levels, we are probably observing primarily the effect of foreign direct investment: that is, among poor countries with near-zero intellectual property protection, increases bring in more foreign investment and in doing so directly raise R&D spending. In higher-income countries with larger economies, foreign investment is not an issue, and increases in intellectual property have little or no effect on innovation.

The Lerner (2002) study is especially notable because he examined all significant changes in patent law in all countries over the last 150 years. His conclusion: “Consider, for instance, policy changes that strengthen patent protection. Once overall trends in patenting are adjusted for, the changes in patents by residents of the country undertaking the policy change are negative, both in Great Britain and in the country itself. Subject to the caveats noted in the conclusion this evidence suggests that these policy changes did not spur innovation.” This, in summary, is what is currently known as the “patent puzzle”—although as we will explain, it is substantially coherent with a theory of innovation that emphasizes the gains from competition and first-mover incentives, rather than benefits from the monopoly power of patents.

Evidence at the sectoral level of the US economy shows the same disconnect between patenting and productivity. In Boldrin, Correa, Levine, and Ornaghi (2011), we carried out a sequence of statistical tests and econometric estimations on two datasets: an original microeconomic dataset obtained by combining firm-level information obtained through Compustat, the National Bureau of Economic Research, and the Bureau of Labor Statistics and an enriched version of the dataset used by Aghion, Bloom, Blundell, Griffith, and Howitt (2005) in their study of industry-level mark-ups. Conclusions must of course be drawn with care from this kind of data because, across industries, the strength of competition, patenting, and productivity are simultaneously determined and intertwined with technological change. With that reservation appropriately noted, at the industry level there is, in general, no statistically significant correlation between measures of productivity (whether measured by labor or total factor productivity) and of patenting activity (whether measured by number of patents or citations of patents).

We then investigated the relationships between patents, competition, and productivity further. When we regressed measures of patents (or patent citations) on a measure of competition (as measured by the inverse of profitability) used by Aghion, Bloom, Blundell, Griffith, and Howitt (2005), we found a positive relationship that is remarkably robust to changes in industry classification, time period, and set of sampled industries. That is, patents were more common in competitive industries. We also studied the correlation between the same measure of competitive pressure and objective measures of labor productivity growth. In our preferred specification, we found that average annual growth of productivity in the sectors with the highest level of competition is up to 2 percent bigger than in the sectors with the lowest level of competition. These are strikingly large differences when cumulated over various decades, as it is the case in our dataset. This finding of a positive correlation between competition and productivity at the sectorial level replicated a pioneering, and unfortunately forgotten, pattern reported in Stigler (1956).

The accumulated findings of no positive relationship between patenting and productivity are not conclusive, and arguments have raged over the specific data used, whether to look for a structural break in the data, how the researcher seeks

to correct for endogeneity, and so on.² However, it is fair to say that the sector-level, national, and cross-national evidence fail to provide any clear empirical link from patents to innovation or to productivity. This lack of connection is consistent with the view that the use of patents either as a defensive or as a rent-seeking tool is more widespread than one might have predicted. In addition, the empirical evidence is consistent with the proposition that greater competition, not patents, is the main factor leading to innovation and greater productivity.

Theory and Practice of Patents and Innovation

There is little doubt that providing a monopoly as a reward for innovation increases the incentive to innovate. There is equally little doubt that granting a monopoly for any reason has the many ill consequences we associate with monopoly power—the most important and overlooked of which is the strong incentive of a government-granted monopolist to engage in further political rent seeking to preserve and expand its monopoly or, for those who do not yet have a monopoly, to try to obtain one. These effects are at least to some extent offsetting: while the positive impact of patents is the straightforward partial equilibrium effect of increasing the profits of the successful innovator to the monopolistic level, the negative one is the subtler general equilibrium effect of reducing everybody else's ability to compete while increasing for everyone the incentive to engage in socially wasteful lobbying efforts.

Downstream Innovation, Defensive Patenting, and Patent Trolls

In the long run, even the positive partial equilibrium effect of patents in providing an incentive for innovation may be more apparent than real: the existence of a large number of monopolies created by past patent grants reduces the incentives for current innovation because current innovators are subject to constant legal action and licensing demands from earlier patent holders. The downstream blocking effect of existing monopoly grants on incentives for future innovation

² For a sense of these controversies, Aghion, Bloom, Blundell, Griffith, and Howitt (2005) find an “inverted-U” relationship between the extent of competition, as measured by the inverse of mark-ups, and a measure of patenting activity, based on a dataset of US patents of UK firms. In other words, they find that the maximum innovative effort (as measured by patents) occurs at some “intermediate” position between a high and low level of competition. However, Hashmi (2011) reexamines the inverted-U relationship using data from publicly traded US manufacturing firms and finds a robust positive relationship between the inverse of markups and citation-weighted patents. Correa (2012) reexamines the same dataset of UK firms and shows that the prediction of an inverted-U is overturned when allowing for the possibility that innovations follow a “memory process,” where the current probability of introducing a new innovation increases when a firm successfully innovated in the previous period. He also finds a structural break in the data in 1981, when the Court of Appeals for the Federal Circuit was established to hear appeals of patent cases. Overall, Correa finds a positive innovation–competition relationship for the memory industries before the 1982 reform, but no relationship between innovation and competition for those industries that he classifies as memory-less.

has greatly increased in recent decades because modern products are made up of so many different components. The recent—and largely successful—efforts of Microsoft to impose a licensing fee on the large and expanding Android phone market is but one case in point. With the exception of Motorola Mobility, all the handset manufacturers have agreed to the fee, and Motorola lost its first battle against the fee in spring 2012—fought not in court but in the more receptive domain of the US International Trade Commission (Investigation Number 337-TA-744, May 18, 2012). Microsoft is attempting to charge a licensing fee solely over a patent involving the scheduling of meetings—a rarely used feature of modern smartphones. The meeting-schedule feature is but one of many thousands of patented “ideas” used in a modern smartphone, and each owner of each patent potentially can charge a licensing fee. Hence, the main dynamic general equilibrium effect of a patent system is to subject future inventions to a gigantic hold-up problem: with many licenses to be purchased and uncertainty about the ultimate value of the new innovation, each patent holder, in raising the price of his “component,” imposes an externality on other patent holders and so charges a higher than efficient licensing fee. In Boldrin and Levine (2005) and Llanes and Trento (2009), we and others have explored the theory; and many case studies involving patents (and other fractionated ownership problems) can be found in Heller (2008).

To understand more about the actual effect of patents in the real world, consider the recent purchase by Google of Motorola Mobility, primarily for its patent portfolio—not for the ideas and innovations in that portfolio. Few if any changes or improvements to Google’s Android operating system will result from the ownership or study of these software patents. Google’s purpose in obtaining this patent portfolio is purely defensive: it can be used to countersue Apple and Microsoft and blunt their legal attack on Google. These remarks apply to the vast bulk of patents: they do not represent useful innovation at all and are just weapons in an arms race. This is not news: the same message emerged decades ago from the Levin, Klevorick, Nelson, and Winter (1987) and Cohen, Nelson, and Walsh (2000) surveys of research and development managers.

One could argue that the costs of building up a patent portfolio to engage in this sort of defensive patenting are not too large: after all, it can cost as little as \$15,000 to file a successful patent application, and filing applications on a larger scale might be cheaper. However, the acquisition of large patent portfolios by incumbents creates huge barriers to entry. In the smartphone market, for example, Apple is the market leader and Microsoft is unable to produce a product that appeals to consumers. Each are incumbent firms with a large patent portfolio. In this market, Google is the new entrant and innovator and, while wealthy, Google found itself lacking a large defensive patent portfolio. Hence we see both Apple and Microsoft attacking Google with patent litigations, generating hundreds of millions in wasteful legal costs and no social benefit whatsoever.

Despite the fact that patents are mostly used for arms races and that these, in turn, are driven by patent trolls, there does not yet exist convincing formal models of the ways in which this interaction can inhibit innovation. In a pure arms

race theory, if all firms get counterbalancing patent portfolios and all innovate, then they would all have innovated in the absence of patents—hence, patents do not encourage innovation. This follows because with counterbalancing patent portfolios, no firm can sue any other firm—exactly as would be the case in the absence of patents. Hence in this setting patents simply add a cost to innovation: if you wish to innovate, you must acquire an expensive patent portfolio to avoid trolls. On the other hand if a patentholder does not produce a marketable product and hence cannot be countersued—like Microsoft in the phone market or other patent trolls in other markets—then patents become a mechanism for sharing the profits without doing the work. In this scenario, not only do patents discourage innovation, but they are also a pure waste from a social standpoint.

Patents and Information Disclosure

Another widely cited benefit of patent systems—although not so much in the economics literature—is the notion that patents are a substitute for socially costly trade secrecy and improve communication about ideas. From a theoretical point of view, the notion that patents are a substitute for trade secrecy fails in the simplest model. If a secret can be kept for N years and a patent lasts M years, then an innovator will patent when $N < M$. In other words, ideas will be patented when it seems likely that the secret would have emerged before the patent expired and not patented if the secret can be kept. In practice, it is uncertain when the secret will leak out, but it can be shown that the basic intuition remains intact in the face of uncertainty (Boldrin and Levine 2004; Ponce 2007).³

It is also the case that the extent of practical “disclosure” in modern patents is as negligible as the skills of patent attorneys can make it. It is usually impossible to build a functioning device or software program from a modern patent application; this is made especially clear by the fact that some patented ideas do not and cannot work. For example, US Patent 6,025,810 was granted for moving information through the fifth dimension. While detailed studies of the usefulness of disclosure in patent applications are not available, companies typically instruct their engineers developing products to avoid studying existing patents so as to be spared subsequent claims of willful infringement, which raises the possibility of having to pay triple damages. According to sworn testimony by Google’s chief of Android development during the legal battles between Oracle and Google (for example, Niccolai 2012), the engineers that developed Android were unaware of Apple (or other) patents, and so were unlikely to have been helped by them. The opinion of Brec (2008), a Microsoft developer, reflects that of many practitioners:

[Microsoft policy is for developers to] never search, view, or speculate about patents. I was confused by this guidance till I wrote and reviewed one of my

³ A more subtle point is that secrecy may bias the type of inventive activity away from innovations that are not easily kept secret to those that can be. In this symposium, Moser offers some of the historical evidence on this point.

own patents. The legal claims section—the only section that counts—was indecipherable by anyone but a patent attorney. Ignorance is bliss and strongly recommended when it comes to patents.

The related idea that patents somehow improve communication about ideas, thereby creating some positive externality—a notion key to the “public–private” partnership between governments and private research organizations in which the government funds the research and then gives the private organization a monopoly over what is developed in the course of research—is backed by neither theory nor evidence. It is impossible to study the history of innovation without recognizing that inventors and innovators exchange ideas as a matter of course and that secrecy occurs, when it occurs, typically in the final stages of an innovation process when some ambitious inventors hope to corner the market for a functioning device by patenting it. A good case in point is that of the Wright brothers, who made a modest improvement in existing flight technology that they kept secret until they could lock it down on patents, then used their patents both to monopolize the US market and to prevent further innovation for nearly 20 years (Shulman, 2003). The role that Marconi and his patent played in the development of the radio is altogether similar (Hong 2001), as are innumerable other stories. At the opposite extreme we have, again among many, the example of the Cornish steam engine discussed in Nuvolari (2004, 2006). Here engineers exchanged nonpatented ideas for decades in a collaborative effort to improve efficiency. The contemporary FLOSS (Free/Libre and Open Source Software) community is another successful example of how collaboration and exchange of ideas can thrive without the monopoly power granted by patents.

First-Mover Advantages and Incentives for Innovation

In most industries, the first-mover advantage and the competitive rents it induces are substantial without patents. The smartphone industry—laden as it is with patent litigation—is a case in point. Apple derived enormous profits in this market before it faced any substantial competition. The first iPhone was released on June 29, 2007. The first serious competitor, the HTC Dream (using the Android operating system) was released on October 22, 2008. By that time, over 5 million iPhones had been sold, and sales soared to over 25 million units during the subsequent year, while total sales of all Android-based phones were less than 7 million. In the tablet market, the iPad has no serious competitor as of late 2012 despite having been introduced on April 10, 2010. While it is hard to prove this delayed imitation also would have occurred in the complete absence of patents, intuition suggests—and our formal model in Boldrin and Levine (2004) predicts—that there is little reason to assert patent rights while the first-mover advantage is still active. Apple did not initially try to use patents to prevent the Android phones from coming into its market and the subsequent “patents’ fight” has been taking place largely after 2010; these facts are consistent with a substantial first-mover advantage. How valuable for Apple was the delay in the Android phones entry? Largely because Apple kept its

first-mover advantage in spite of a large imitative entry in this market, the value of Apple stock—during a severe market downturn—rose by a factor of approximately five. While there may have been some delay in entry from the competition due to Apple's threat—since executed—of patent litigation, the fact is that similar but less-successful devices had been available for a number of years before Apple finally cracked the market.

Less anecdotal than the story of the iPhone is the survey of research and development managers in Cohen, Nelson, and Walsh (2000). Here, over 50 percent of managers indicate lead time (first-mover advantage) is important to earning a return on innovation; outside the pharmaceutical and medical instruments industry, less than 35 percent of managers indicate that patents are important.

To understand patents in practice, it is necessary to examine the lifecycle of industries (for example, Jovanovich and MacDonald 1994; Scherer 1990). Typically a new, hence innovative, industry begins with a competitive burst of entries through which very many innovators try hard to get their products to market. In these early stages, many firms bring different versions of the new product to the market (think of the American auto industry in the early twentieth century or the software industry in the 1980s and 1990s) while demand for the new product grows rapidly and the quality of products is rapidly improved. At this stage of the industry lifecycle, the price elasticity of demand is typically high; what is important is not to dominate the market, but rather to get your own products quickly to market and to reduce costs. From the perspective of competing firms, your cost-reducing innovation is good for me in the same way that my cost-reducing innovation is good for you—hence, let us all imitate each other and compete in the market.

As the industry matures, demand stabilizes and becomes much less price elastic; the scope for cost-reducing innovations decreases; the benefits of monopoly power grow; and the potential for additional product innovation shrinks. Typically there is a shakeout in which many firms either leave the industry or are bought out. The automobile industry is a classical historical example, but many readers will have a more vivid memory of the bursting of the dot-com bubble, which makes this point even more forcefully. At this stage of the industry lifecycle, rent seeking becomes important and patents are widely used to inhibit innovation, prevent entry, and encourage exit. If we look at patent litigation in practice—and as predicted by theories of first-mover competition (Boldrin and Levine 2004, among others)—it takes place when innovation is low. When an industry matures, innovation is no longer encouraged; instead, it is blocked by the ever-increasing appeal to patent protection on part of the insiders.

While patent litigation has increased, few patents are actively used. Patent litigation often involves dying firms that have accumulated huge stockpile of patents but are no longer able to produce marketable products and that are now suing new and innovative firms. For example, Texas Instruments was one of the first producers of microchips, and many in our generation remember the capabilities of their first TI calculator. But Texas Instruments was unable to make the transition to the personal computer revolution and became, for a while, the symbol of a dying company

trying to stay alive by suing the newcomers.⁴ In more recent times, Microsoft—once the giant bestriding the software industry—has been unable to make the leap to portable devices such as telephones and tablet personal computers. Thus, Microsoft now uses patent litigation to try to claim a share of the profits Google generates in this market. Back in 1991, Bill Gates said: “If people had understood how patents would be granted when most of today’s ideas were invented and had taken out patents, the industry would be at a complete standstill today . . . A future start-up with no patents of its own will be forced to pay whatever price the giants choose to impose.” Today, Microsoft lobbies across Europe and Asia for the introduction of software patents, a prize it has already obtained in its home country.

The cost of litigating patents is not insubstantial either. Bessen and Meurer (2008) used stock market event studies to estimate the cost of patent litigation: they estimate that during the 1990s such costs rose substantially until, at the end of the period, they constituted nearly 14 percent of total research and development costs. A related but more difficult-to-quantify phenomenon is the rise of uncertainty caused by the legal system. A case in point is the NTP Inc. patents that were used to threaten the Blackberry network with a shutdown. In 2006, Research in Motion (RIM), the producer of Blackberry, agreed to pay \$612.5 million to license the patent in question from NTP (Svensson 2006). The patent was later invalidated by the court—but RIM did not get its money back (Salmon 2012). Here, the behavior of a single judge cost RIM more than half a billion dollars. In this setting, it is no surprise that patent trolls hope to get rich quickly.

It is easier to list the main social welfare implications of the tradeoff between costs of legal monopoly and incentives to patent holders than it is to calculate their magnitudes. Still, the provisional evidence we have suggests that the net welfare effects of the current patent system could easily be negative. It is somewhat conventional to think of welfare losses from distortions as small, with the idea that welfare triangles due to monopoly power are small being the paradigmatic case in point. Unfortunately, monopolies have no incentive to avoid large social losses even when the private gains are small. Witness, for example, the fact that patented pharmaceutical products often sell for hundreds of times the marginal cost of production, as some astonishing pricing differences between the US and the European markets show. Most revealing is the empirical study of the Quinolones family of drugs (Chaudhuri, Goldberg, and Gia 2006). It measures the economic consequences of the introduction of pharmaceutical patents for this family of drugs and concludes that the consequence of patent protection to India will be nearly \$300 million in welfare losses—while the gain to the pharmaceutical companies will be less than \$20 million.⁵

⁴ Texas Instruments is such an important source of litigation that empirical work on patent litigation usually uses a dummy variable for TI. Empirical studies of the importance of firms no longer doing business in an industry to litigation can be found in Bessen and Meurer (2005) and Hall and Ziedonis (2007).

⁵ Although the focus of this paper is on patents rather than copyright, it is worth noting that most of the copyright wars revolve around measures to prevent piracy, empirically a relatively minor factor as far as profits of media corporations are concerned (see for example Sinha, Machado, and Sellman 2010; Danaher, Dhanasobhon, Smith, and Telang 2010; Sanchez 2012).

Pharmaceuticals

This brings us to the controversial issue of drug patents. The standard argument says: No patents, no drugs. The total cost of developing a new drug, including failures, is quickly approaching the \$1 billion mark (DiMasi, Hansen, and Grabowski 2003). So how can anyone, faced with such a gigantic fixed cost and a microscopic marginal cost of reproduction, innovate without the protection of patents? But consider the following facts: Under current law, the chemical formula and the efficacy of the cure as established by clinical trials are made available to competitors essentially for free. About 80 percent of the initial fixed cost of drug development comes from Stage III clinical trials, a public good that legislation requires be *privately* produced. The downstream social cost of monopoly pricing of pharmaceutical products is highest for life-saving drugs, and the cost of monopoly pricing of other pharmaceutical products is also quite high. Given all this, various economists, such as Kremer and Williams (2009), have argued that *if* government intervention is indeed needed in this market, a system of prizes might be superior to the existing system of monopolies.

There are four things that should be born in mind in thinking about the role of patents in the pharmaceutical industry. First, patents are just one piece of a set of complicated regulations that include requirements for clinical testing and disclosure, along with grants of market exclusivity that function alongside patents. Second, it is widely believed that in the absence of legal protections, generics would hit the market side by side with the originals. This assumption is presumably based on the observation that when patents expire, generics enter immediately. However, this overlooks the fact that the generic manufacturers have had more than a decade to reverse-engineer the product, study the market, and set up production lines. Lanjouw's (1998) study of India prior to the recent introduction of pharmaceutical patents there indicates that it takes closer to four years to bring a product to market after the original is introduced—in other words, the first-mover advantage in pharmaceuticals is larger than is ordinarily imagined. Third, much development of pharmaceutical products is done outside the private sector; in Boldrin and Levine (2008b), we provide some details. Finally, the current system is not working well: as Grootendorst, Hollis, Levine, Pogge, and Edwards (2011) point out, the most notable current feature of pharmaceutical innovation is the huge “drought” in the development of new products.

With these four factors in mind, it is possible to make proposals for reforming the pharmaceutical industry along with the patent system. For example, we could either treat Stage II and III clinical trials as public goods (where the task would be financed by National Institutes of Health, who would accept bids from firms to carry out this work) or by allowing the commercialization of new drugs—at regulated prices equal to the economic costs of drugs—if they satisfy the Food and Drug Administration requirements for safety even if they do not yet satisfy the current (overly demanding) requisites for proving efficacy. In other words, pharmaceutical companies would be requested to sell new drugs at “economic cost” until efficacy is proved, but they could start selling at market prices after that. (It is ensuring

the efficacy—not the safety—of drugs that is most expensive, time-consuming, and difficult.) In this way, companies would face strong incentives to conduct or fund appropriate efficacy studies where they deem the potential market for such drugs to be large enough to bear the additional costs. The new policy could begin with drugs aimed at rare diseases, which, because of their small potential market, are not currently worth the costs of efficacy testing; without the new policy, they might never make it to market at all. If this new progressive approval approach works for rare diseases, it could be adopted across the board. Our broader point is that, rather than just ratcheting up patent protection, there are a number of moves we could make to reduce the risks and cost of developing new drugs.

The Political Economy of Patents

We do believe, along with many of our colleagues, that a patent system designed by impartial and disinterested economists and administered by wise and incorruptible civil servants could serve to encourage innovation. In such a system, very few patents would ever be awarded: only those for which convincing evidence existed that the fixed costs of innovation were truly very high, the costs of imitation were truly very low, and demand for the product was really highly inelastic. (The curious reader may check Boldrin and Levine, 2008a, for a more detailed explanation as to why these three conditions need to be satisfied to make a patent socially valuable). There is little dispute, among these same colleagues, that the patent system as it exists is very far from satisfying such requirements and it is, in fact, broken. To quote a proponent of patents, Shapiro (2007): “A growing chorus of scholars and practitioners are expressing concerns about the operation of the US patent system. While there is no doubt that the US economy remains highly innovative, and there is no doubt that the patent system taken as a whole plays an important role in spurring innovation, the general consensus is that the US patent system is out of balance and can be substantially improved.” Actually, we believe the evidence is clear that the patent system taken as a whole does not play an important role in spurring innovation. But if a well-designed and well-administered patent system *could* serve the intended purpose, why not reform it instead of abolishing it?

To answer the question we need to investigate the political economy of patents: why has the political system resulted in the patent system we have? Our argument is that it cannot be otherwise: the “optimal” patent system that a benevolent economist–dictator would design and implement is not of this world. It is of course fine to recommend patent reform. But if political economy pressures make it impossible to accomplish that reform, or if they make it inevitable that the patent system will fail to meet its goals, then abolition—preferably by constitutional means as was the case in Switzerland and the Netherlands prior to the late nineteenth century—is the proper solution. This political economy logic brings us to advocate dismantlement of the patent system.

The political economy of patent protection is shaped by many players, but “consumers” are not prominent among them. On one side, the side of the potential patentees, there are individual inventors, corporate inventors, and patent trolls. Other players include the patent office, the patent lawyers who file and litigate patents, and the courts where the litigation takes place. The rules of the game are established by some combination of legislation, judicial action, and custom. But because patenting is a technical subject about which few voters know anything with clarity, interests of voters are not well represented. In many spheres of government regulation, this lack of representation for voters has often led to “regulatory capture”—as Stigler (1971) and other public choice theorists have argued—where regulators act in the interests of the regulated, not the broader public. Nowadays, if there is one “regulator” who is captured, it is the one in charge of regulating patents. To understand why, we need to understand the motivation and incentives of the relevant players.

Let us start with the US Patent Office and the infamous “one-click” patent #5960411 issued to Amazon in September 1999. According to 35 U.S.C. 103, the statute under which the Patent Office operates, to obtain a patent “the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been not obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains . . .” Now consider the patent in question, which claims, among other things, a monopoly over:

11. A method for ordering an item using a client system, the method comprising: displaying information identifying the item and displaying an indication of a single action that is to be performed to order the identified item; and in response to only the indicated single action being performed, sending to a server system a request to order the identified item whereby the item is ordered independently of a shopping cart model and the order is fulfilled to complete a purchase of the item.

The idea of taking a single action to accomplish a goal is hardly innovative, and applying the idea of taking a single action to making a purchase is obvious to anybody who has ever used a soft drink machine. Purchases were already being made over the Internet in 1999. It was thus clear that orders would be made by a credit card, and either the credit card information would be provided at the time of the transaction, or stored in advance by the retailer. Either way, the user must identify itself when the purchase is made. Those obvious steps are exactly what Amazon describes in its patent, albeit with a few flow charts thrown into the eleven-page patent application. But through the fog of those flow charts, it is relatively easy to see that the verbal description of the single-click procedure applies equally well to what happens on the Amazon site *and* to what happens in front of millions of vending machines every day. The Amazon patent was reexamined by the US Patent Office starting in May 2006. After a preliminary finding that, indeed, “obvious” means “obvious” even

at the Patent Office, the office then reversed itself and in October 2007, reaffirmed the Amazon patent, albeit limiting its scope slightly. So we cannot dismiss such an absurd patent as an aberration.

What lead the US Patent Office to interpret, essentially, the words “not obvious” as meaning “obvious”? The Patent Office is constantly under pressure from applicants and their lawyers to be more generous in issuing patents—that is, to adopt lower standards of obviousness and steeper standards for what is considered “prior art.” The following statement by David Kappos (2010), director of the US Patent Office concerning the allowance rate—what fraction of patents are accepted—is revealing: “Overall in FY 2010, the allowance rate increased to 45.6%, compared to an allowance rate of 41.3% in FY 2009 . . . So, while we still have a lot of work to do, I think we are on the right path.” Apparently, accepting a higher fraction of patents applications is defined as “the right path.” Talk about “regulatory capture”!

Patent lawyers play a large role in the political economy of patents. According to Quinn (2011), who is a patent attorney, legal fees for filing a patent run upwards of \$7,000 and roughly half are rejected. In 2010, according to the US Patent Office, 244,341 patents were issued, which would imply roughly \$3 billion in legal fees per year. Obviously, patent attorneys as a group have a tremendous incentive to see that more patents are issued. This insight helps us understand better the role of the courts and their relatively recent reform. In 1982—lobbied by patent lawyers—Congress passed the Federal Courts Improvement Act, which moved federal patent appeals out of the regular court system to a special court system for dealing with patents. Naturally, many of the judges for this new court were chosen from the ranks of patent attorneys. For example, when a court voted, in a 1994 decision, to expand the scope of patents to software (*In re Kuriappan P. Alappat, Edward E. Averill and James G. Larsen* 33 F.3d 1526 [July 29, 1994]), of the six judges who voted in favor, half had previously been patent attorneys, while of the two that voted against, neither had been. The referee of the patent game is biased both materially and ideologically. As Landes and Posner (2004, p. 26) write in their discussion of the political economy of patents: “That has been the experience with the Federal Circuit; it has defined its mission as promoting technological progress by enlarging patent rights.”

Notice, too, that many patent lawsuits have a public goods aspect. Consider a case in which the plaintiff is asserting that its patent has been infringed. If the plaintiff wins the lawsuit, by confirming its monopoly position it appropriates all the benefits of winning the lawsuit. A victory by the defendant, by contrast, benefits partly itself, but also other firms that might be sued by the plaintiff for patent infringement as well as consumers who would have a more competitive market. Thus, the defendant receives only a slice of the overall benefits from winning the lawsuit, and will be willing to spend less on such lawsuits than it would if it were to receive all the benefits. This dynamic is nothing but the patent court version of the (already noted) fundamental asymmetry in the distribution of economic incentives that defines the foundations of the political economy of patent law.

Finally, political economy can be influenced by how standard terminology frames a problem. Landes and Posner (2004) point out that there is an “ideological”

argument in support of stronger patent rights: supporters of free markets tend to favor institutions of private property, and patents and copyright are intellectual “property.” Hence, strengthening them is ideologically and politically consistent with the general principle that “private property is good for growth.” But as we (Boldrin and Levine 2008b) and many others elsewhere have argued, patents are just a monopoly, not property.

Given this set of players and their incentives, the patent game moves naturally towards its equilibrium, as we have observed over time. Two centuries or so ago, patents were restricted in their areas of applicability and limited in both depth and duration over time; they were somewhat “reasonable,” to the extent social gains and costs seemed balanced. But we have witnessed a steady process of enlargement and strengthening of patent laws. At each stage, the main driving force was the rent-seeking efforts of large, cash-rich companies unable to keep up with new and creative competitors. Patent lawyers, patent officials, and wannabe patent trolls usually acted as foot soldiers. While this political economy process is pretty straightforward in broad terms, we are still missing an empirical, quantitative analysis of the stakes involved and of the gains and losses accruing to both the active players and to the rest of society, from the general public to the innovators that never emerged due to preexisting patent barriers.

Perhaps surprisingly, despite the key importance of political economy in understanding why we have the patent system we have, economists have had relatively little to say on the subject. The few prominent papers that we know of on this subject typically build from analyses very similar to what we have presented here—but then shy away from drawing the logical conclusions.

For example, Landes and Posner (2004) recognize that patent laws are mostly designed by interest groups keen to increase their monopoly rents, not aggregate welfare, and that this drove the enormous growth in patent legislation and judiciary activity during the last 30 years. The more elaborate writing by Scherer (2009) on “The Political Economy of Patent Policy Reform in the United States” follows a similar approach. It focuses on the fact that “government emphasis on patent systems increased” while academic research was starting to become more and more aware that patents are playing a minor positive role, if any at all, in creating incentives for high R&D and in fostering productivity growth. After providing a concise and very well-informed historical survey of all major changes in US patent policies over the last century or so, Scherer (p. 195) wonders why the political system would increase patent protection so much in light of the fact “that the record of debates on the enabling bill contains no solid evidence that the change would in fact stimulate R&D, and that there is no evidence of an acceleration in company-financed R&D between the 27 years before the bill was enacted and the 18 years thereafter.” He then extends the same argument to the international arena, paying particular attention to the case of pharmaceutical patents. While Scherer’s language and arguments are strongly critical of current trends in patents, he does not seek to explain why an institution, such as the patent system, that was supposed to be theoretically sound would degenerate into something so socially damaging over same 30-year

period that academic researchers were realizing the institution's limitations and potential dangerousness.

In our view, even insightful writers such as Landes and Posner (2004) and Scherer (2009) seem unable to shake themselves free of the belief that patents are essential in fostering innovation and that any problems can be fixed with some tweaks to the patent system; they fail to seriously consider the possibility of intrinsic problems with the design of the institution itself. This belief in patents flies in the face of the structural realities: Marginal extensions of patents result in substantially higher per capita rents for the few holders of the right while marginally reducing the individual welfare of the much larger number of nonpatent holders. The rent of the monopolist is a lot higher than an individual consumer's deadweight loss, so the monopolist has an incentive to perpetuate the system while the individual consumer has no incentive to fight it. Those who possess a patent do not hold a "property right" in the conventional sense of that term, but they do hold a socially granted "monopoly" right, and will tend to leverage whatever initial rents their monopoly provides in order to increase their monopoly power until all potential rents are extracted (and, in all likelihood, also largely dissipated by the associated lobbying and transaction costs). This scenario helps explain how patents interact with the industry lifecycle—why patents are either ignored or scarcely used in new and competitive industries, while being highly valued and overused in mature and highly concentrated ones.

Conclusion

In 1958, the distinguished economist Fritz Machlup in testimony before Congress famously said: "If we did not have a patent system, it would be irresponsible, on the basis of our present knowledge of its economic consequences, to recommend instituting one. But since we have had a patent system for a long time, it would be irresponsible, on the basis of our present knowledge, to recommend abolishing it." A proposal to abolish patents may seem "pie in the sky." Certainly, many interim measures could be taken to mitigate the damage caused by the current system: for example, properly enforcing the standard that patents should only be granted for nonobvious insights; requiring genuine disclosure of working methods in patents (the opposite of certain recent "protectionist" proposals to institute secret patents); and allowing an "independent invention" defense against claims of patent infringement. But why use band-aids to staunch a major wound? Economists fought for decades—ultimately with considerable success—to reduce restrictions on international trade. A similar approach, albeit less slow, should be adopted to phase out patents. Because policy proposals are often better digested and metabolized in small bites, here is our list of small reforms that could be easily implemented.

- 1) Patents are time limited, which makes it relatively easy to phase them out by phasing in ever shorter patent durations. This conservative approach also

- has the advantage that if reducing patent terms indeed has a measurable effect on innovation, the process can be reversed.
- 2) Stop the rising tide that, since the early 1980s, has extended the set of what can be patented and has shifted the legal and judicial balance substantially in favor of patent holders.
 - 3) Because competition fosters productivity growth, antitrust and competition policies should seek to limit patents when they are hindering innovation. This policy may be of particular relevance for high-tech sectors, from software to bioengineering, to medical products and pharmaceuticals.
 - 4) Current international trade negotiations that affect patents often occur as part of either the Agreement on Trade-Related Aspects of Intellectual Property Rights (*TRIPS*), which was signed in 1995 as part of the World Trade Organization negotiations, or as part of the World Intellectual Property Organization, an agency of the United Nations. The nature of these agreements and organizations is well indicated by the use of the propaganda term “intellectual property” in their titles. In both cases, these talks are often focused on how to prevent ideas from high-income countries from being used in low-income countries—what we would characterize as essentially a neo-mercantilist approach toward free trade in goods and ideas. We should be highly cautious about this agenda. Within a couple of decades, the “balance of trade in ideas” between the US and European economies and emerging economies in Asia might easily equalize or reverse. Engaging in “mercantilism of ideas” may seem favorable to certain large US firms now, but such rules may become costly to the US economy if they are applied to protect patents held in the future by producers in the now-developing Asian economies.
 - 5) If the US economy is to have patents, we may want to start tailoring their length and breadth to different sectoral needs. Substantial empirical work needs to be done to implement this properly, although a vast legal literature is already pointing in this direction.
 - 6) Patents should not be granted based only on technological insights, but should also take economic evidence into account. For example, if an invention is easy to copy or has a high fixed cost, then patent protection to provide an incentive for the inventor may be more suitable. Ultimately, patents should be awarded only when strictly needed on economic grounds, as spelled out earlier.
 - 7) We advocate returning to the rule prior to the Bayh–Dole Act of 1980 according to which the results of federally subsidized research cannot lead to patents, but should be available to all market participants. This reform would be particularly useful for encouraging the dissemination of innovation and heightening competition in the pharmaceutical industry.
 - 8) In several industries, notably pharmaceuticals, it would be useful to rethink all of the government policies that bear on incentives for invention. The broad point is that there are a number of ways to reduce the risks and cost of developing new drugs, rather than just trying to ratchet up patent protection.

In general, public policy should aim to decrease patent monopolies gradually but surely, and the ultimate goal should be the abolition of patents. After six decades of further study since Machlup's testimony in 1958 has failed to find evidence that patents promote the common good, it is surely time to reassess his conclusion that it would be irresponsible to abolish the patent system. The patent system arose as a way to limit the power of royalty to award monopolies to favored individuals; but now its primary effect is to encourage large but stagnant incumbent firms to block innovation and inhibit competition.

■ *We are grateful to the editors, the referees, and to Richard Stallman for a careful reading and comments.*

References

- Aghion, Phillipe, Nick Bloom, Richard Blundell, Rachel Griffith, and Peter Howitt. 2005. "Competition and Innovation: An Inverted-U Relationship." *Quarterly Journal of Economics* 120(2): 701–728.
- Boldrin, Michele, Juan Correa Allamand, David K. Levine, and Carmine Ornaghi. 2011. "Competition and Innovation." In *Cato Papers on Public Policy*, Vol. 1, edited by J. A. Miron, 109–172. Cato Institute.
- Boldrin, Michele, and David K. Levine. 2004. "Rent Seeking and Innovation." *Journal of Monetary Economics* 51(1): 127–60.
- Boldrin, Michele, and David K. Levine. 2005. "The Economics of Ideas and Intellectual Property." *Proceedings of the National Academy of Sciences* 102(4): 1252–56.
- Boldrin, Michele, and David K. Levine. 2008a. "Perfectly Competitive Innovation." *Journal of Monetary Economics* 55(3): 435–53.
- Boldrin, Michele, and David K. Levine. 2008b. *Against Intellectual Monopoly*. Cambridge University Press.
- Bessen, James, and Michael J. Meurer. 2005. "The Patent Litigation Explosion." BU School of Law Working Paper 05–18, Boston University.
- Bessen, James, and Michael J. Meurer. 2008. *Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk*. Princeton University Press.
- Brec, Eric. 2008. "NIHilism and Other Innovation Poison." MSDN Blogs, November 1. http://blogs.msdn.com/b/eric_brechner/archive/2008/11/01/nihilism-and-other-innovation-poison.aspx.
- Chaudhuri, Shubham, Pinelopi K. Goldberg, and Panie Gia. 2006. "Estimating the Effects of Global Patent Protection in Pharmaceuticals: A Case Study of Quinolones in India." *American Economic Review* 96(5): 1477–1514.
- Cohen, Wesley M., Richard R. Nelson, and John P. Walsh. 2000. "Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)." NBER Working Paper 7552.
- Correa, Juan A. 2012. "Innovation and Competition: An Unstable Relationship." *Journal of Applied Econometrics* 27(1): 160–66.
- Danaher, Brett, Samita Dhanasobhon, Michael D. Smith, and Rahul Telang. 2010. "Converting Pirates without Cannibalizing Purchasers: The Impact of Digital Distribution on Physical Sales

and Internet Piracy." March 3. Available at SSRN: <http://ssrn.com/abstract=1381827> or <http://dx.doi.org/10.2139/ssrn.1381827>.

DiMasi, Joseph A., Ronald W. Hansen, and Henry G. Grabowski. 2003. "The Price of Innovation: New Estimates of Drug Development Costs." *Journal of Health Economics* 22(2): 151–85.

Gallini, Nancy T. 2002. "The Economics of Patents: Lessons from Recent U.S. Patent Reform." *Journal of Economic Perspectives* 16(2): 131–154.

Gates, Bill. 1991. "Challenges and Strategy." Memo, Microsoft Corporation, May 16. <http://www.std.com/obi/Bill.Gates/Challenges.and.Strategy>.

Grootendorst, Paul, Aidan Hollis, David K. Levine, Thomas Pogge, and Aled M. Edwards. 2011. "New Approaches to Rewarding Pharmaceutical Innovation." *CMAJ: Canadian Medical Association Journal* 183(6): 681–85.

Hall, Bronwyn H., and Rosemarie Ham Ziedonis. 2007. "An Empirical Analysis of Patent Litigation in the Semiconductor Industry." <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.69.5271>.

Hashmi, Aamir Rafique. 2011. "Competition and Innovation: The Inverted-U Relationship Revisited." Available at SSRN: <http://ssrn.com/abstract=1762388> or <http://dx.doi.org/10.2139/ssrn.1762388>.

Heller, Michael. 2008. *The Gridlock Economy: How Too Much Ownership Wrecks Markets, Stops Innovation, and Costs Lives*. Basic Books.

Hong, Sungook. 2001. *Wireless: from Marconi's Black-Box to the Audion*. MIT University Press.

Jaffe, Adam B. 2000. "The U.S. Patent System in Transition: Policy Innovation and the Innovation Process." *Research Policy* 29(4–5): 531–57.

Jovanovic, Boyan, and Glenn M. MacDonald. 1994. "The Life Cycle of a Competitive Industry." *Journal of Political Economy* 102(2): 322–47.

Kanwar, Sunil, and Robert Evanson. 2001. "Does Intellectual Property Protection Spur Technological Change?" Levine's Working Paper Archive, no. 122247000000000455.

Kappos, David. 2010. "Reflections on the USPTO Dashboard." Director's Forum: David Kappo's Public Blog, October 13. http://www.uspto.gov/blog/director/entry/reflections_on_the_uspto_dashboard.

Kremer, Michael, and Heidi Williams. 2009. "Incentivizing Innovation: Adding to the Toolkit." In *Innovation Policy and the Economy*, Vol. 10, edited by Josh Lerner and Scott Stern, 1–17. Chicago University Press.

Landes, William M., and Richard A. Posner. 2004. *Political Economy of Intellectually Property Law*. Washington, DC: AEI-Brookings Joint Center for Regulatory Studies.

Lanjouw, Jean O. 1998. "The Introduction of Pharmaceutical Product Patents in India: Heartless Exploitation of the Poor and Suffering?" NBER Working Paper 6366.

Lerner, Josh. 2002. "Patent Protection and Innovation over 150 Years." http://www.epip.eu/papers/20030424/epip/papers/cd/papers_speakers/Lerner_Paper_EPIP_210403.pdf (quotes are from this version). Abridged version published in 2002 as "150 Years of Patent Protection," *American Economic Review* 92(2): 221–25.

Lerner, Josh. 2009. "The Empirical Impact of Intellectual Property Rights on Innovation: Puzzles and Clues." *American Economic Review* 99(2): 343–48.

Levin, Richard C., Alvin K. Klevorick, Richard R. Nelson, and Sidney G. Winter. 1987. "Appropriating the Returns from Industrial Research and Development." *Brookings Papers on Economic Activity*, no. 3, Special Issue on Microeconomics, pp. 783–820.

Llanes, Gastón, and Stefano Trento. 2009. "Patent Policy, Patent Pools, and the Accumulation of Claims in Sequential Innovation." *Economic Theory* 50(3): 703–25.

Machlup, Fritz. 1958. "An Economic Review of the Patent System." Study commissioned by the Senate Judiciary Subcommittee on Patents, Trademarks, and Copyrights, 85th Congress, 2nd session. <http://mises.org/document/1182/>.

Niccolai, James. 2012. "Android Developers Ignored Sun Patents, Google Exec Testifies." *Computerworld*, May 9.

Nuvolari, Alessandro. 2004. "Collective Invention during the British Industrial Revolution: The Case of the Cornish Pumping Engine." *Cambridge Journal of Economics* 28(3): 347–63.

Nuvolari, Alessandro. 2006. "The Making of Steam Power Technology: A Study of Technical Change during the British Industrial Revolution." *Journal of Economic History* 66(2): 472–76. Cambridge University Press.

Ponce, Carlos J. 2007. "More Secrecy . . . More Knowledge Disclosure? On Disclosure Outside of Patents." Levine's Working Paper Archive, no. 122247000000001600.

Quinn, Gene. 2011. "The Cost of Obtaining a Patent in the US." *IPWatchdog.com*, January 28. <http://www.ipwatchdog.com/2011/01/28/the-cost-of-obtaining-patent/id=14668/>.

Salmon, Felix. 2012. "Why Patent Trolls Don't Need Valid Patents." March 4. Reuters. <http://blogs.reuters.com/felix-salmon/2012/03/04/why-patent-trolls-dont-need-valid-patents/>.

Sanchez, Julian. 2012. "How Copyright Industries Con Congress." Posted at Cato@Liberty, <http://www.cato-at-liberty.org/how-copyright-industries-con-congress/>.

Scherer, F. M. 1990. *Industrial Market Structure and Economic Performance*. Houghton Mifflin Company.

Scherer, F. M. 2009. "The Political Economy of Patent Policy Reform in the United States." *Journal on Telecommunications and High Technology Law* 7(2):167–216.

Shapiro, Carl. 2007. "Patent Reform: Aligning Reward and Contribution." NBER Working Paper 13141.

Shulman, Seth. 2003. *Unlocking the Sky: Glenn Hammond Curtiss and the Race to Invent the Airplane*. Harper Perennial.

Sinha, Rajiv K., Fernando S. Machado, and Collin Sellman. 2010. "Don't Think Twice, It's All Right: Music Piracy and Pricing in a DRM-Free Environment." *Journal of Marketing* 74(2): 40–54.

Stigler, George J. 1956. "Industrial Organization and Economic Progress." In *The State of the Social Sciences*, edited by Leonard D. White, 269–82. University of Chicago Press.

Stigler, George J. 1971. "The Theory of Economic Regulation." *Bell Journal of Economics and Management Science* 2(1): 3–21.

Svensson, Peter. 2006. "Long-Running BlackBerry Patent Battle Ends with \$612.5 Million Settlement." *The Daily Reporter* (Associated Press), March 4. http://news.google.com/newspapers?nid=1907&dat=20060304&id=5bVGAAAIBAJ&sjid=0_0MAAAIBAJ&pg=4540,273762.

US Central Intelligence Agency. n.a. *The 1990 CIA World Fact Book*. Available from Project Gutenberg: <https://ia700401.us.archive.org/32/items/the1990ciaworldf00014gut/world12.txt>.