Science and Politics

An A-to-Z Guide to Issues and Controversies

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Patents

The role of government, and hence of politics, in providing patents and other intellectual property rights (IPRs) can best be understood in the context of the intellectual and policy fights over free market approaches to science and technology (S&T). Ideally, free markets should motivate progress in S&T through competition amongst producers and consumers. That is, if there exist a large number of rational, free, well-informed consumers and producers, then producers should be forced by competition to innovate in order to attract business and investment. These innovations will take the form of new or more efficient goods and services, often the result of research and development (R&D) in new technology. However, critics argue that the free market model is an oversimplification of how progress in S&T actually works. Specifically, the free market model contains hidden, unrealistic, or absurd assumptions that must hold true in order for it to obtain results. If these assumptions are ignored, then an economy or economic policies based on these theories may malfunction. Some of these assumptions involve IPRs and government's role in providing them. And since the definition and extent of that role, and of IRPs themselves, can have distributive effects, they naturally assume a political nature as contending interest groups battle over resources and outcomes.

The central political tension over patents is that inventors of, and investors in, established technologies wish to maximize their patent monopoly, while new entrants, consumers, and copy-cats benefit from minimizing that monopoly. Moreover, the backers of established technologies often consist of wealthy financial interests and big business, while new innovators and consumers often come from less powerful or less wealthy backgrounds. These tensions can become international, with advanced technological nations pushing for stronger IPRs in those lesser-developed economies that habitually violate them. Thus, there has long existed a fairly neat political-economic fault line separating those actors who want to strengthen IPRs and those who seek to weaken them. And since patents are determined by legislation and enforced by government officials, the differing interests of these contending groups regularly manifest themselves in the political fights over IPR regimes.

Origins of the Modern Patent Debate

The intellectual and public policy debate over patents is best illustrated by the response to the dramatic wave of S&T progress that occurred in the USSR soon after World War II. Soviet S&T performance shocked Americans because communist economic policies had long been assumed to be antithetical to technological innovation. But the Soviets had made S&T progress a national priority. Following the Bolshevik victory in 1917, Vladimir Lenin initiated plans to gradually reform the backwards, quasi-feudal Russian economy into a progressive communist enterprise, but one free of capitalist or free-market influences. After Lenin's death, Joseph Stalin used the totalitarian power secured by Lenin to further

coerce Russian society into rapid industrialization and modernization. Stalin's approach sometimes required violent measures, including brutal purges of Russia's intelligentsia and forced relocation of entire populations. Yet, despite the strain on the Russian people from Stalin's policies and the catastrophic losses endured during the war with Hitler, the USSR emerged from World War II as the only superpower to challenge the United States in S&T.

After 1945, the Soviets even seemed to create a technological gap between themselves and the United States, which then appeared to widen at a frightening pace. Military-oriented technological advances increased the speed, firepower, and throw-weights of the Soviet armed forces to new levels, which led in turn to speculation about whether Soviet industrial technology was outpacing that of American competitors. By 1949, Moscow had succeeded in developing an atomic fission bomb and, by 1955, successfully tested an even more powerful hydrogen fusion bomb. In 1957, Americans were further shocked when the Soviets became the first to launch a satellite into Earth's orbit. Meanwhile, Americans were still testing rockets that consistently exploded, crashed, or simply failed to launch. These apparent weaknesses in U.S. military technology led to fears of a "bomber gap" and eventually a "missile gap" between the United States and USSR. Concerns about Soviet technological superiority were soon amplified by the achievements of Soviet scientists. In 1956, Soviet chemists won a science Nobel Prize, the country's first. Six more Nobel Prizes were awarded to Soviet physicists throughout the 1950s and 1960s. Soviet success soon appeared to spread into every scientific field including astronomy, theoretical physics, mathematics, computing, metallurgy, synthetics, and several fields of engineering (aeronautics, petroleum, nuclear) (Graham 1993).

Powered entirely by government intervention, the rapid pace of Soviet S&T defied the free market logic that many Americans had long accepted as gospel. Other empirical evidence further upset free market disciples. For example, the miraculous industrialization of Japan between the 1890s and the 1930s had previously established the credibility of government-driven technological change. Even more challenging were the dramatic successes enjoyed by the many Allied and Axis government R&D programs during World War II. These programs had produced many of the innovations that came to define the modern world, including the jet engine, the electronic computer, radar, antibiotics, and a long list of others. Perhaps most undeniable was the beneficial role of the state in developing atomic weaponry. The colossal mobilization of resources required by the Manhattan Project (see "Manhattan Project" chapter) demonstrated to Americans what both science and government were capable of accomplishing. No longer was scientific research divorced from technological innovation. No longer was government relegated to the sidelines. Each had taken an essential role in driving technological change. But in American society during the Cold War, the rising specter of totalitarian communism and the increasing role of government in technological innovation sparked new debates about the sources of innovation. Americans now confronted the question of whether perfect market competition was the best method by which to produce scientific research and new technology.

Economist Kenneth Arrow formalized the answer in 1962. He argued that innovation is essentially just the production of new knowledge, specifically the production of high-risk and high-cost scientific and technical knowledge. The problem with knowledge is that it is "non-rival" and "non-excludable." That is, knowledge can be used simultaneously by many people (non-rival) and it is nearly impossible to keep people from accessing that knowledge (non-excludable). Therefore, when high-cost, high-risk S&T knowledge is produced, it is very easy to copy and transmit at a low cost with low risk by observers. Arrow argued that because of these characteristics, free market economies will tend to under-invest in technological innovation and scientific research. After all, there is no reason to endure the risk and cost of investing in the creation new S&T knowledge if outsiders can copy it so easily. As a result, free market actors should rationally decide to limit their investments in R&D, and simply duplicate the research of others. Hence free market economies should tend to under-perform in S&T.

To solve this problem, Arrow argued that governments must create property rights in S&T knowledge and support markets for trading these property rights. That is, government must intervene in markets so as to make it difficult for S&T knowledge to be easily copied, shared, or used without the owner's consent. Equally important, the state must ensure that S&T property rights can be transferred. For if individuals and businesses can sell or license S&T knowledge for a profit, then there exist incentives for them to invest in R&D. Violations of these S&T knowledge rights can be easily enforced with fines or

bans. Of course, all this is merely economic jargon for intellectual property rights (trademarks, trade secrecy laws, patents, and copyrights).

The Politics of Patents

IPRs were not invented by economists during the twentieth century. Patents have been granted by governments in Western Europe and the Americas for centuries. But often, these patents were grants of monopoly from ruling elites to family favorites, allies, and important business interests. That is, the primary purpose of pre-modern patents was not necessarily to incentivize the production of S&T, but tools with which to gather and anchor political-economic power around a country's royal family. For example, in Europe, the disclosure of knowledge in a patent was historically the exception rather than the rule. Disclosure emerged there as an irregular practice only during the early 1800s, and was not mandated by law until much later. And while available to the English since 1624, patents there were often monopolies on production granted by the monarch to his/her domestic allies in return for political or financial support rather than instruments of early S&T policy. Patents awarded in the UK did not legally require the specification of patented knowledge until the 1883 Patents Act. In general, only during the eighteenth century, and often much later, did patents begin to attain their modern function as a solution to market failures in the production of S&T (May and Sell 2006).

Modern IPR systems have become quite complicated, but underlying them is a simple contract between a society and its inventors. In the United States, this simple contract was written into law in 1790 and has since become a primary policy tool in incentivizing progress in American science and technology. It holds that, in exchange for openly sharing their discoveries with society, inventors are granted a short-term monopoly on their inventions. The purpose of the monopoly is to allow inventors, and their financial backers, to earn a suitable return on their investment. Often the duration of this monopoly varied by nation. For example, prior to a 1973 agreement in Europe, the United Kingdom had awarded fourteen-year patents, while France and Germany offered fifteen years. In the United States, patents traditionally came with a seventeen-year monopoly. Since 1995, the international Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) has created a general twenty-year patent duration for members of the World Trade Organization, with some exceptions for developing countries (Dutfield and Suthersanen 2008).

But problems and political fights over the definition, award, and enforcement of patents have always existed. For example, Eli Whitney, inventor of the cotton gin in 1793, was famously unable to enforce his patent on it and lost a large fortune in unclaimed revenues. Over in Europe, the abuses and inefficiencies of the centuries-old Dutch patent system were so bad that voters there abolished it in 1869 for over four decades. The Swiss opted to go without a patent system altogether until 1907. The standard logic of economic interests drove political conflicts over patent laws. New innovators, consumers, and established business interests fought over the monopoly rights, and rents, guaranteed by patents in fairly predictable patterns. Likewise, the more technologically advanced states in Europe pressured their backward neighbors, as well as the United States which was then playing catch-up, to strengthen their IPR regimes.

Political and policy debates over IPRs have become more complex, and interesting, since the mid-1990s. Economists have recognized additional problems that may undermine the ability of patents to foster innovation, especially in certain high-tech industries. For example, modern patents have become loaded with increasingly vague claims and a decreasing amount of public information regarding these claims. This handicaps the knowledge disclosure benefits of patents (Hall and Harhoff 2012). In some cases, frivolous and broad patent claims ("everything under the sun") are used to block legitimate innovations, or to sue for excessive licensing fees and legal settlements. The result has been a dramatic increase in, and expense of, patent litigation. Such litigation, or even the mere threat of it, adds large costs to the innovation process to the point where, in some industries, litigation costs begin to outweigh the potential profits from innovation (Jaffe and Learner 2004).

In some economic sectors, critics argue that abuse of the patent system has become rampant. The exploitation of flaws in the system is most easily visible in the unusual cases that often make headlines. In one infamous case in 1999, the J. M. Smucker Company obtained a patent for peanut butter and jelly sandwiches with the crusts cut off. The firm then used this patent to sue small grocery owners for selling crust-less sandwiches without a legally obtained license. Smuckers' lawsuits in defense of

U.S. Patent No. 6,004,596 were eventually rejected by a federal appeals court, but only after over four years of litigation.

More serious threats to innovation involve patents on the software and computerized business processes that now pervade economic and social life. For example, after Amazon acquired a patent on its "one-click" ordering process, it threatened all websites that offered similar functionality, even filing a suit against competitor Barnes & Noble. Priceline.com attempted something similar with their "name your own price" auction patent, which they used to sue or threaten Microsoft, Expedia, and a handful of other competitors. In 2011, one of the most popular music distributors, Spotify, was sued for violating overly broad music streaming patents, while the "Angry Birds" video game developer has been sued over the way in which it encourages players to advance to a new level within the game. These lawsuit and patent activities do very little to incentivize innovation. They merely allow the collection of rents on overlapping, obvious, or previously invented technologies.

As the advantages of patent litigation became more obvious, patents on generic business methods began to be sought out by firms in the health care and medical industries during the early 2000s. For instance, in 2002 two Montreal-based researchers obtained a patent on a technique for treating autoimmune disorders such as Crohn's disease. Instead of patenting a specific drug, they linked specific ranges of blood metabolite levels to the dosage of an existing drug required for treatment. Prometheus Laboratories then bought this patent and, in 2011, used it to sue the Mayo Clinic for establishing its own system that linked metabolite levels to the amount of dosage prescribed. This "indicate a need" patent had the implications of allowing patents for all sorts of formalized technical advice including financial stock tips or cooks writing recipes, not just doctors making diagnoses.

The Ideal Patent: Supporters and Opponents

So what does the ideal patent look like? A good patent should act essentially in the same way that a physical fence serves to protect a vacant lot of property. The purpose of the fence is not necessarily to keep all people out, all of the time. There will always be the periodic trespasser. Rather, the real problem facing the vacant lot owner is protecting against someone else using or building on the land without the owner's permission. An effective fence is one that clearly defines the boundaries of privately held land, indicating to outsiders where they can and cannot build. If the fence is absent or does not clearly mark the boundaries of the lot, then an innocent investor may inadvertently build on privately held land. This is the problem with some twenty-first century patents. They have become so broad and vague that even well-meaning investors can risk losing their investment, or be forced to pay heavy costs, in litigating boundary violations.

Patents must therefore clearly define the boundaries of the intellectual property they protect. Private knowledge that is closed to outside use needs to be clearly distinguishable from knowledge that is in the public domain and available to be freely built upon (Bessen and Meurer 2009). The evidence for the usefulness of well-demarcated and "fenced-in" patents can be seen in the rapid innovation rates of the nineteenth and early twentieth centuries. This era was typified by a host of mechanical, chemical, and early electrical inventions that were characterized by clear, easily definable boundaries. Likewise, in the modern pharmaceutical and chemical industries, patents can be granted to protect specific molecules or production techniques. Again, these types of S&T knowledge boundaries are clear, therefore in these industries, patents work just as Arrow described. But in numerous other twenty-first century high-tech sectors, such as clinical medicine, mathematical processes, statistical analyses, and biotechnology, the increasing vagueness of patent claims prevents the establishment of the predictable, legal boundaries that foster innovation.

The problem of open-ended and vague patents has been exacerbated by the relative decline in resources and authority given to the U.S. Patent Office (USPTO). In the 1990s, the USPTO was encouraged by Congress to zealously grant patent protection so as to incentivize investment in American S&T. However, relative constraints on budgets and personnel in the years thereafter has limited the ability of the USPTO to properly assess the quality of patent applications or identify prior art. This has forced the USPTO to become an unwilling accomplice in approval of increasingly vague and broad patent claims.

Some of the worst cases of patent abuse arise when businesses exploit flaws within the system without contributing any innovation whatsoever. Specifically, businesses might choose to pursue extremely flexible patent claims solely in the hope of scaring off other

competitors. Alternatively, businesses can use specialized litigation techniques to keep claims hidden or constantly appended over time. These techniques unproductively complicate and confuse the boundaries on intellectual property. The profitability in exploiting these vague and overlapping boundaries has unintentionally created an entirely new business model. Known as "patent trolls" some firms exist only to acquire patents without any intention of utilizing the innovations that they protect. These "patent trolls" instead use their patents to threaten litigation so as to secure fees from legitimate innovators. For example, in 2010, some 400 companies were sued by the Texas-based firm Geotag because they violated the company's patent (U.S. Patent No. 5,930,474) on its "find a retailer" feature that lets users locate their nearest store by providing a ZIP code. Although not the inventor of this technology, Geotag was able to use the purchased patent to file predatory lawsuits suits. In another set of lawsuits, The SCO Group software firm stopped creating or selling new products in 2002. Rather, in an attempt to avoid bankruptcy, it instead purchased UNIX copyrights to extort fees and settlements from *all* open-source Linux operating system users. Their legal campaign took aim at some of the world's largest and most profitable corporations. Even though The SCO Group's strategy eventually failed, some leading innovators, such as IBM, Red Hat, Novell, AutoZone, and DaimlerChrysler, suffered millions of dollars in litigation costs in the process of defending themselves.

Additional considerations arise when new S&T knowledge overlaps with existing patents or is distributed amongst multiple owners. When patented knowledge is cumulative and necessary for subsequent innovations, it is unclear whether or not patents provide the best method to stimulate innovation. For example, if the single 1948 patent on the transistor had been more broadly and zealously applied, then it might have stifled or delayed the creation of all the computer, television, satellite, automobile, airplane, and weapon technologies that built cumulatively upon that single patent. Complicating issues even more are "patent thickets": large numbers of basic patents spread across multiple owners upon which a single, new, complex technology might infringe. Patent thickets often result in conflicting and ambiguous claims to ownership that drive up the costs of coordinating, negotiating, and licensing patented technology. They make it difficult, for example, to develop new software or create a new telecommunication device without violating one or more patents owned by multiple firms (Boldrin and Levine 2008). This caused problems during the mid-2000s when investors attempted to introduce new technology into the 3G communications market, only to discover that they had to negotiate a thicket that involved over forty firms and 8,000 patents.

Finally, the large amount of resources required to innovate in an advanced economy means that patents tend to do a great deal more to spur investment in S&T in developed countries than they do in poor and less-developed countries (Grossman and Lai 2004). Yet, while less-developed countries have limited resources and a smaller S&T knowledge base, their products must still compete with those exported by technological juggernauts such as the United States, Japan, or Europe. Sure, patents work well to help General Electric compete with Siemens, Pfizer with Roche, or Apple with Nokia. However, a small start-up firm in Uruguay or Indonesia trying to enter global markets will find it difficult to create enough low-cost indigenous innovation to compete with the exports of high-tech firms from the advanced economies. On the other hand, if that small firm could copy (some might say "steal") pre-existing technical knowledge, then it might be able to build upon (or some may argue "free-ride upon") those investments in order to come up with a feasible product. Patents and IPR regimes in wealthy nations can create an insurmountable obstacle to development for poor countries by locking them out of high-tech industries. Therefore, it comes as no surprise that less-developed countries often disregard foreign IPRs until their products are able to compete on the same technological footing.

Despite these problems, patents still remain imperative to innovative policy and strides are being taken to repair the system's flaws. In the United States during the early 2000s, the Supreme Court started to reign in the misuse of patents. More recently, the American Invests Act of 2012 converted the United States from a first-to-invent system to a first-to-file system in order to reduce costly litigation and uncertainty. Meanwhile, members of the World Trade Organization have negotiated an Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), which creates a worldwide, comprehensive IPR regime. However, some critics believe that none of these measures go far enough to modernize the patent system (Autor 2013; Raustiala and Sprigman 2012). Nor is there yet consensus on what the best national, much less global, patent system

might look like. The many different policy variables and interest groups ensure a high degree of complexity in, and conflict over, IPR designs. Some of the more basic considerations include the length of monopoly granted, how specific protected knowledge claims are, the scope of knowledge covered, the fees for grants and renewals, and filing procedures. Each of these variables determines, to a great extent, the incentives investors face to fund innovation, and even seemingly innocent changes in patent characteristics can have serious impacts on the rate of innovation. Hence patents and other IPRs will likely remain objects of political fights and policy debates throughout the twenty-first century.

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PCBs

Polychlorinated biphenyls (PCBs) are a poster child of modern chemistry's relationship with nature. These compounds were at once crucial to twentieth century industrialization yet threatened—and indeed continue to threaten—human and ecological health in subtle and insidious ways. Their story is hardly unique: DDT, a popular and effective pesticide used in the early and mid-twentieth century followed a similar narrative arch, beginning with promise, falling into controversy, and ending with the thud of stark realization. In 1979 the United States finally took action to ban these hazardous chemicals, but for many decades the scientific community warned the public and policy makers about the threat of PCBs.