

Chapter 3: Innovation Under Competition

We have just seen numerous examples showing the frenetic pace of creation in the absence of copyright. Of course people love to create stories, music, movies – and even news. So perhaps you agree that copyright is not such a big deal, and even that it is not such a good idea. However, while we may hope to live lives free of boredom in the absence of intellectual monopoly – what about invention, the driving force of economic growth and prosperity? Would we benefit from all of the machines, drugs and ideas that surround us if not for the beneficent force of patent law? Can we risk the foundation of our prosperity and growth by eliminating patents? In fact the evidence shows that the invention of marvelous machines, drugs and ideas does not require the spur of patents. If anything, the evidence shows, it is the other way around: patents protection is not the source of innovation, but rather the unwelcome consequence that, eventually, tames it.

We have already looked at the computer software industry: at its inception and during its most creative decades it was essentially free of patents while making almost no use of copyright protection in order to prevent entry by competitors. As creativity slowed down, consolidation took place and a few large monopolists emerged (one in particular), the demand for copyright first and patents later grew. Nowadays copyright and patents stand at the core of the software industry, which has become both monopolized and substantially less innovative than in the past.¹ Innovation and creativity comes from the competitive fringe, which has great difficulty hiding behind intellectual property protection. Neither Google nor YouTube nor Skype are the golden eggs of the patents' chicken, which in fact they do not use to retain their competitive advantage. By contrast, Microsoft would have had a hard time imitating and then catching up with Netscape had the latter managed to patent the idea of a browser, something it could do today. These are the facts: the great role of patents in giving us modern software is fantasy.

We shall see now that the story of software is far from unique. Most successful industries have followed the same pattern: intellectual property plays little role at the pioneering stage when new innovations and better and cheaper goods come pouring in. Then, when the creative reservoir runs dry, there is the desperate scramble for the pork that intellectual property provides. Because this is true for every well-established sector, from cars to

electricity, from chemical and pharmaceutical to textile and computer, and because this is widely documented in every decent history of such industries, we will not bore the reader by going through these most traditional, if economically crucial, sectors. Instead, in keeping with our odd tradition of looking there where our arguments have the fewer chances of holding water, we will try to make our point by looking at some less obvious industries – for example, where imitation is cheap and there is lots of fierce competition.

World Without Patent

Historically, very few ideas and innovations have been rewarded with government protected monopolies. Although the Venetians introduced limited patent protection to “*accutissimi Ingegni, apti ad excogitar et trouar varij Ingegnosi artificij*” in 1474, this was an exceptional provision aimed at attracting particularly skilful artisans and merchants from other states. Such it remained for about a century and a half, with kings, princes and *dogi* giving or taking away exclusive privileges as they saw fit either to promote the economic vigor of the state or, more often, to promote the financial well being of their purse.

It was the English Parliament that, in 1623, pioneered patent law in its modern version with the aptly named *Statute of Monopolies*. At the time the euphemism of “intellectual property” had not yet been adopted – that a monopoly right and not a property right was being granted to innovators no one questioned. Moreover, the act of Parliament introducing the *Statute* did not create a new monopoly. It took the power of granting monopoly away from the monarchy (represented at the time by King James I) and lodged it instead with the Parliament. This basic fact is often missed in discussions over the role of patents in the economic development of the UK. Before the Statute was enacted, the royal power to sell monopolies (on either new or old products, it did not matter: think of the salt monopoly) went completely unchecked and its use aimed at maximizing royal revenues. The economic incentives of innovators or, more generally, of entrepreneurs was nobody’s concern in issuing letters of patent.

The Statute, therefore, replaced the super-monopolistic power of expropriation and arbitrary grants of monopoly the Crown had enjoyed until then, with the milder temporary monopoly actual inventors would receive from Parliament. This, no doubt, represented progress in terms of private property rights and incentives to private economic initiative. Further, the range of

products to which patent protection could and would be given was greatly reduced, as it was restricted to actual inventions (that is to say, forget the monopoly of salt) that satisfied the tight requirement of

they be not contrary to the law nor mischievous to the state by raising prices of commodities at home, or hurt of trade, or generally inconvenient²

Last, but not the least

All Monopolies and all Commissions, Grants, Licenses, Charters and Letters Patent heretofore made or granted or hereafter to be made or granted to any Person or Persons, Bodies Politic or Corporate whatsoever, of, or for the sole Buying, Selling, Making, Working or Using any Thing within this Realm... or of any other Monopolies, or of Power, Liberty or Faculty... are altogether contrary to the Laws of this Realm, and so are and shall be utterly void and of none effect and in no wise to be put into use or execution.³

In current parlance, the Statute of Monopoly amounted to a gigantic “liberalization/deregulation” of the British economy, which came together with a strengthening of private property rights, a reduction of royal power and the establishment of restrictive – by current standard: extremely restrictive – criteria for patent grants. These historical facts are worth keeping in mind vis-à-vis the frequent claims that the introduction of patent privileges in seventeenth century England played a crucial role in spurring the subsequent industrial revolution. The *Statute* did not replace intellectual competition with intellectual monopoly, as we are often lead to believe, but an indefinite and broad government monopoly with a definite and restricted private monopoly. The second is a much lesser evil than the first, as it provides the innovator with both protection and economic incentives, whereas before there was nothing but royal arbitrium and widespread monopoly.

The *Statute of Monopolies*, in any case, defined the basic concept of patents and allowed for the possibility of a fourteen years monopoly provided that: “they be not contrary to the law nor mischievous to the state by raising prices of commodities at home, or hurt of trade, or generally inconvenient.” The *Statute of Anne*, in

1710, extended and revised the law, while also introducing copyright. Until these formal laws were introduced, patents and copyright were either nonexistent, used as a form of governmental extortion through the sale of economic privileges, or were a tool for harassing scientists and philosophers, as Galileo and many others across Europe were forced to learn. Insofar as the British system of patent was helpful in inducing the industrial revolution, it is likely that the limitation it placed on the arbitrary power of government to block and monopolize innovation was the most important factor.

After the British legislative innovations of 1623/24 and 1710, imitation proceeded rather slowly in the rest of Europe: for good or ill the transmission of ideas always takes time. A patent law was enacted in France in 1791; because it was based on the principle that no examination of any kind was required it amounted to no more than a “registry of inventions,” often with very many duplicates, variations, and so on. It was also quite costly to get a patent, and the latter was declared void if the inventor tried to patent the invention also in another country, a small detail revealing the mercantilist foundation of intellectual property, something that, as we argue later, remains essential to current legislation. As a consequence of all this, the French system did not introduce much monopoly until it was reformed in 1844.

It is only between the end of the nineteenth and the beginning of the twentieth century that countries such as France, Germany, Italy and Spain came to adopt fairly comprehensive intellectual property laws. By this time, innovation, the rule of law, and the ownership of ideas in these countries was widespread, and the introduction of intellectual property laws served to create private monopolies rather than to limit the arbitrary power of government. Germany enacted a comprehensive patent law, introducing for the first time the principle of mandatory examination, only in 1877. Still, German patent law was mostly restricted to processes, not products; in particular, chemical products did not become patentable until much later. A number of significant holdouts remained until even after the Second World War; for example, Switzerland and the Netherlands and, to a lesser extent, Italy.

As for the United States, the adoption of intellectual property laws started with the Patent Act of 1790, and extended progressively to more and more areas of business. The first U.S. patent was granted in 1790 to Samuel Hopkins of Philadelphia for “making pot and pearl ashes,” a cleaning formula used in soap

making. Since then the applicability of patent law has increased steadily, with new industries and areas of invention being added one after the other. The length of patent terms has also been increased, while the court's rulings have leaned more and more in favor of patent holders. There have been a few, temporary, setbacks to this trend, and they have been associated either with renewed antitrust efforts or with situations of national emergency, such as WWI and, especially, WWII. This fact, by itself, is revealing and worth noticing: that patents could or could not be used in one area of research or in a whole industry, has never been the outcome of a spontaneous, well informed and well reasoned decision by the legislative branch. It has always happened in bits and pieces by mixing court rulings with small legislative changes, and always upon "request" from the industry that "needed" to be monopolized, or "protected". It would take another book to spell out the fascinating political economy account of how, one mature industry after another, patentability grew over time because of lobbying by would-be monopolists that had run out of steam for inventing and were too afraid of newcomers or foreign competitors. Various historical episodes (the 1870s, and the 1970-1980s, especially) give the impression that slow productivity growth favors extensions of "patentability", as all three branches of government gave in to the pressure of incumbent firms trying to preserve profitability by increasing monopoly power instead of competing harder.

The crucial fact, though, is that the following causal sequence never took place, either in the US or anywhere in the world. The legislative branch passed a bill saying "patent protection is extended to inventions carried out in the area X", where X was a yet un-developed area of economic activity. A few months, years, or even decades after the bill was passed, inventions surged in area X, which quickly turned into a new, innovative and booming industry. In fact, patentability always came after the industry had already emerged and matured on its own terms. A somewhat stronger test, which we owe to a doubtful reader of our work, is the following: can anyone mention even one single case of a new industry emerging due to the protection of existing patent laws? We cannot, and the doubtful reader could not either. Strange coincidence, is it not?

During the last twenty-five or thirty years the "everything should be patented" trend has set in, especially in the United States, with the European Union, as always, barking at the heels. Even in the U.S., business practices and financial securities were

not subject to patent prior to 1998 and software code was not patentable until 1981. In most of the rest of world they still cannot be patented.

As is transparent from our cursory survey of the countries and sectors to which patent laws have applied, the list of industries that were born and grew in the absence of intellectual property protection is almost endless. Services were not covered by patent laws until the late 1990s and then only in the U.S. and in some particular sectors. The mechanical and metallurgical industries are those in which patent laws were most broadly applied, while the chemical industry was originally only partially affected by intellectual monopoly provisions. In Italy, pharmaceutical products and processes were not covered by patents until 1978; the same was true in Switzerland for processes until 1954, and for products until 1977. Agricultural seeds and plant varieties could not be effectively patented in the United States until 1970, and they still cannot be in most of the world. All kinds of “basic science” from mathematics to physics (and even economics, but no longer finance) has never been and cannot be patented, even if a rapidly growing number of observers are alarmingly pointing out that, at least in the U.S., the “going upstream” tendency in patenting has seriously started to affect the results of very basic research, especially in the biological and life sciences.

We are not alone among economists in noticing these facts; George Stigler, writing in 1956, cites a number of examples of thriving innovations under competition:

When the new industry did not have such barriers [patents and other contrived restrictions on entry], there were an eager host of new firms – even in the face of the greatest uncertainties. One may cite automobiles, frozen foods, various electrical appliances and equipment, petroleum refining, incandescent lamps, radio, and (it is said) uranium mining.⁴

He provides further elaboration in the case of the mail-order business:

There can be rewards – and great ones – to the successful competitive innovator. For example, the mail-order business was an innovation that had a vast effect upon retailing in rural and small urban communities in the United States. The innovators, I suppose, were Aaron

Montgomery Ward, who opened the first general merchandise establishment in 1872, and Richard Sears, who entered the industry fourteen years later. Sears soon lifted his company to a dominant position by his magnificent merchandising talents, and he obtained a modest fortune, and his partner Rosenwald an immodest one. At no time were there any conventional monopolistic practices, and at all times there were rivals within the industry and other industries making near-perfect substitutes (e.g. department stores, local merchants), so the price fixing-power of the large companies was very small.⁵

Since 1955, sticking to the merchandising and distribution sector, we can add to this list such modern innovations as Ray Kroc's fast-food franchise (better known as McDonalds), the 24-hour convenience store, home delivery of pre-cooked food, the suburban shopping mall, franchise-everything (from coffee to hairdressing), the various steps that make up the delivery business of UPS, Federal Express, and DHL, and, obviously, online commerce. That is: pretty much each and every innovation which, during the last half century, has had any lasting impact in the retail and distribution sector was not spurred or protected by patents.

However, these all seem rather obvious if not stereotyped examples. A less obvious but nevertheless familiar form of innovation is emigration. The first English, Dutch, Irish, or Somali immigrant to the United States was no less innovative than the inventor of the airplane, and emigrants are constantly discovering new countries and business opportunities without any need for intellectual monopoly. Indeed, emigration and the formation of new communities is both a prototypical example of the fundamental role played by competitive innovation in the development of human civilization, and a reminder of the fact that the forces of monopoly are always and almost inescapably at work after every great competitive leap forward.

The first immigrant faces a large cost: he must cross the ocean, or desert, or mountain range. He also faces a high risk of failure: who knows what is waiting over there and what living conditions will be like? The cost is much smaller and less risky for imitators – seldom if ever are unsuccessful immigrants imitated. Followers of early settlers already know that the newfound land is hospitable and fertile – and the pioneers are available to inform newcomers about job opportunities and local laws and customs. Yet the common association of “early settlers” with “old money”

or “political influence”, or both, suggests that there is still a substantial advantage to being first.

Sadly, as in other industries, after years have gone by and the number of new opportunities for immigrants diminishes, pressure from early entrants for monopoly protection emerges. Such rent-seeking legislation in the immigration industry we call “immigration and naturalization restrictions” or “quotas”. While economists doubt that these restrictions provide much benefit for the early entrants, there is no doubt that protection from competition from new immigrants is much sought after.

The history of emigration carries also some broader messages about innovation. It shows that free-entry and unrestricted imitation characterize the most successful experiences, while monopolistic restrictions on immigration are often associated with poor subsequent economic performances. One example is the contrasting experiences of the Portuguese/Spanish settlements of Central/South America, and that of the English settlements of North America. The first was limited to small bands of politically connected adventurers, the second was open even to politically unpopular groups such as the Puritans. The economic consequences speak for themselves.

In a similar way, successful new industries are almost invariably the product of innovation cum imitation cum cut throat competition, while many potential successes have been thwarted from the start by the adoption of monopolistic arrangements favoring the very early innovators. It is also true that the more mature and economically successful a country is, the stronger is the internal pressure for the introduction of monopolistic restrictions to immigration. So it is also at the end of the industry life-cycle, that wealthy, mature, and technologically stagnant firms are the breeding ground of monopolistic restrictions purchased through the constant lobbying of politicians and regulators.

The Industrial Revolution and the Steam Engine

It has been argued that the Industrial Revolution took place when it took place (allegedly, sometime between 1750 and 1850) and where it took place (England) largely because patents giving inventors a period of monopoly power were first introduced by enlightened rulers at that time and in that place. The exemplary story of James Watt, the prototypical inventor-entrepreneur of the time, is often told to confirm the magic role of patents in spurring invention and growth. As we pointed out in the introduction, this is far from being the case.

The pricing policy of the Boulton and Watt enterprise was a classical example of monopoly pricing: over and above the cost of the materials needed to build the steam engine, they would charge royalties equal to one-third of the fuel-costs savings attained by their engine in comparison to the Newcomen engine. Notice two interesting properties of this scheme: it allows for price discrimination, and it is founded on the hypothesis that, thanks to the patent protection, no further technological improvement will take place. It allows for price discrimination because, given the transport technology of the time, the price of coal – and horses, the alternative to the Newcomen engine being horses – varied substantially from one region to another. It assumes that technological improvement will be stifled, because it is based on the idea that only the Watt engine could use less coal than the Newcomen engine. No surprise, then, that Boulton and Watt spent most of their time fighting in court any inventor, such as Jonathan Hornblower, who tried to introduce a machine either superior to theirs or, at least, superior to the Newcomen engine. It will also come as no surprise to our readers that, in the Cornwall region where copper and tin were mined and coal was expensive, a number of miners took to “pirating” the engine. This naturally brought about a legal dispute with Boulton and Watt, which ended only in 1799 with the symbolic victory of the two monopolists. Symbolic, because their patent expired a year later.

The episode that interests us here, though, lies in the pace and nature of innovation after the expiration of the Boulton and Watt patents. In 1811 after the Boulton and Watt patents had expired “[...] a group of mine [...] managers decided to begin the publication of a monthly journal reporting the salient technical characteristics, the operating procedures and the performance of each engine.”⁶ Their declared aims were to permit the rapid individuation and diffusion of best-practice techniques, and to introduce a climate of competition among the various mines’ engineers. The publication enterprise continued until 1904.

One year later, in 1812, and in the same region the first high pressure engine of the so-called “Cornish” type was built by Richard Trevithick. Interestingly enough, Trevithick did not patent his high-pressure pumping engine, and allowed anybody who wanted to copy it.⁷ It happened to be as efficient as Watt’s, but much more amenable to improvement. This triggered a long and extremely successful period of “competitive-collaborative innovation” in which different firms made small, incremental changes to the original design of the Cornish engine. Such changes

were neither patented nor kept secret, thereby spreading rapidly among other firms in the Cornwall area, allowing and at the same time forcing new improvements from competitors.

As a measure of the social value of competition versus monopoly, consider the following facts. The duty of steam engines (a fundamental measure of their coal-efficiency) that, during the twenty five years of the Boulton and Watt monopoly (1775-1800), had remained practically constant, improved by roughly a factor of five during the 1810-1835 period.

This successful collaborative effort to improve the Cornish engine illustrates the genius of the competitive market. Because of uncertainty in coal mining, a modest number of investors engaged in mutual insurance by each owning shares in a broad cross-section of mines. As is the case with shareholders in publicly traded companies, this means that each investor was able to capture the benefit of innovation, regardless of which particular firm or engineer made the improvement. And indeed, the employment contracts of engineers reflected these incentives. Engineers were employed on a contract basis by particular mines to improve engines, with the understanding that they would publish their results. Investors captured the common gains to all mines from each innovation, while engineers, having signed away the right to monopolize their invention, profited instead from their fees and by the advertising value of publicizing their innovations. Indeed, in many respects this early 19th century competitive-collaborative mine engine improvement system is similar to the modern day open source software system.⁸

The Industrial Revolution period is, when one looks at it without glasses shaded with bias, a mine of examples, both of patents hindering economic progress while seldom enriching their owners, and of great riches and even greater economic progresses achieved without patents and thanks to open competition. Of the many anecdotes, the story of Eli Whitney is particularly instructive. Born in Westboro, Massachussets, in 1765, Whitney graduated from Yale College in 1792. The following year he designed and constructed the cotton gin, a machine that automated the separation of cottonseed from the short-staple cotton fiber. Very much like Watt's engine in the coal districts of England, the cotton gin was enormously valuable in the South of the United States, where it made southern cotton a profitable crop for the first time. Like James Watt, Eli Whitney also had a business partner, Phineas Miller, and the two opted for a monopolistic pricing scheme not dissimilar from the Boulton's and Watt's. They would

install their machines through Georgia and the South, and charge farmers a fee for doing the ginning for them. Their charge was two-fifths of the profit, paid to them in cotton. Not surprisingly, farmers did not like this pricing scheme very much, and started to “pirate” the machine. Whitney and Miller spent a lot of time and money trying to enforce their patent on the cotton gin, but with little success. Between 1794 and 1807 they went around the South bringing to court everyone in sight, yet received little compensation for their strenuous efforts. In the meanwhile, and thanks also to all that “pirating”, the Southern cotton growing and ginning sector grew at a healthy pace.

Ironically, Eli Whitney did eventually become a rich man – not through his efforts at monopolization, but through the wonders of competitive markets. In 1798, he invented a way to manufacture muskets by machine, developing the idea of interchangeable parts and standardized production. Having probably learned his lesson, he did not bother to seek patent protection this time, but instead set up a shop in Whitneyville, near New Haven. Here he manufactured his muskets and sold them to the U.S. Army. So it was not as a monopolist of the cotton gin, but rather as the competitive manufacturer of muskets that Whitney finally became rich.

Agriculture⁹

Among economists the reaction to the idea that economic progress is the fruit of competition is varied. Those belonging to the theoretical variety, interested in matters of pure economic theory and logic, tend to quickly agree and then yawn away the rest of the seminar; the conclusion seeming straightforward. Specialists working in the areas of innovation, economic growth, and industrial organization, long steeped in the conventional wisdom that there is no innovation without monopolization are often certain that the opposite idea cannot possibly be correct, even if uncertain as to why not. There are, however, the specialists in agricultural economics, who react with neither boredom nor rage. Steeped not in the myths of theory, but versed in the facts of agricultural innovation, these specialists point out that until the early 1970s animal and plant species innovation flourished without much in the way of protection from intellectual monopoly. Breeders would develop a new plant variety, the initial seeds of which were sold to farmers at relatively high prices. Farmers were then free to reproduce and resell such seeds on the market and compete with the initial breeders, without the latter bringing them to court because those bushels of, say, Turkey Red wheat were

“illegal copies” of the Turkey Red wheat variety they held a patent on.

A sizeable chunk of innovation in agriculture revolves around plants and animals. Neither the 1793 original nor the 1952 revised version of the U.S. patent code mentioned the possibility of patenting different forms of life, be they animal or vegetable. The issue did not arise during most of the nineteenth century, but a precedent against patenting was established in 1889, when the U.S. Commissioner of Patents rejected an application for a patent to cover a fiber identified in the needles of a pine tree. The Commissioner wisely pointed out that patenting some newly found form of life would be tantamount to attribute monopoly power (and de facto ownership) on all copies of that form of life to be subsequently found, which struck him, as it strikes us, as “unreasonable and impossible.”

The story of agriculture, however, like that in other industries, is also the story of the intellectually bankrupt seeking protection for their old ideas. The discovery of the economic potential of Mendel’s law – imagine a world in which Mendel had managed to patent applications of his law, no longer an impossibility these days – started a long series of attempts to subvert the 1889 doctrine. The National Committee on Plant Patents, created and financed by the country’s breeders, was the leader of an intense lobbying campaign arguing that now, contrary to before, a “new” plant/animal could, in principle, be exactly identified and that its “creation” was equivalent therefore to the invention of a new mechanical tool. Notice an important detail: during the many decades it took to buy monopoly protection from Congress, the breeding industry was, literally, blossoming and growing under conditions of competition and without intellectual monopoly protection. In fact, it had prospered so much that its economic power and ability to influence congress and the public opinion increased to the point that it was able to eventually get the law changed.

Once again we are faced with the basic pattern noted earlier. Innovative and dynamic industries emerge either because intellectual monopoly is not present or because it can easily be bypassed. They grow rapidly because competition and imitation allow and force their firms to innovate or perish. In fact, in the early stages, agricultural innovators often would provide their customers with incentives to copy and reproduce their seeds, as a tool for spreading its usage. However, as the industry grows more powerful and the opportunities for further innovation diminishes,

the value of monopoly protection for the insiders increases, lobbying efforts multiply and most often succeed.

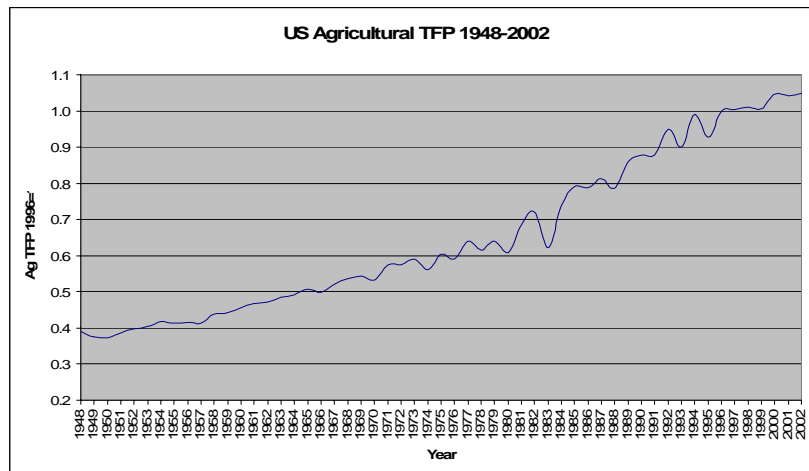
In the case of the breeding industry, a partial victory was first achieved during the Great Depression, with the Plant Patent Act of 1930. The victory was only partial because, due mostly to issues of enforceability, patents were allowed only for plants that could reproduce asexually. It explicitly excluded tuber and sexually reproduced plants. For these crops the scientific knowledge of the times made it impossible to satisfy the Patent Law requisite that a patentable invention be disclosed specifically enough to be identically reproducible.

As the reader may imagine, this limitation did not please the American Seed Trade Association, which had greatly contributed to the lobbying effort. While a useful precedent, the 1930 Act was too weak and covered too few plants, hence it did not really provide breeders with the extensive monopoly power they sought; such weakness revealed itself in the fact that, while agricultural innovations continued at a substantial pace, only 911 plant patents were assigned in the period until the early 1950s. In the meanwhile lobbying by potential monopolists did not go away, instead it intensified as new and powerful interest groups joined the clan. The discovery of the DNA code, and the subsequent development of biological engineering, would, eventually, come to rescue the monopolist's demand for full protection.

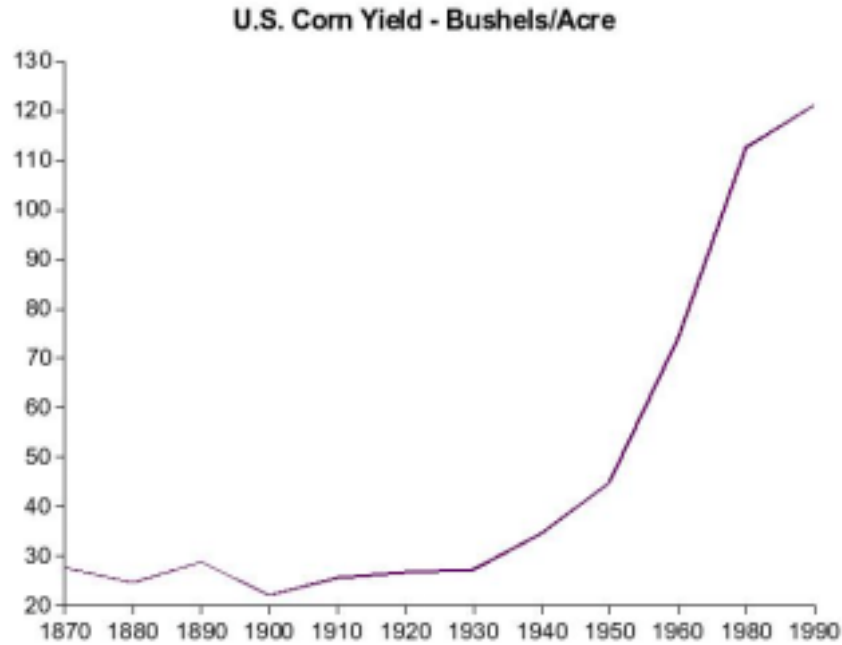
To summarize: (i) before 1930 only some mechanical and chemical inventions related to agriculture could be patented. (ii) In 1930 the PPA offered patent protection to asexually reproduced plants. (iii) In 1970 the PVPA extended such protection to plants that are sexually reproduced. (iv) Between 1980 and 1987 patent protection was extended to the products of biotechnology. One would expect this progressive extension of IP protection to bring about a dramatic acceleration in useful innovation, at least since the early 1970s.

One measure of useful innovation is what economists call Total Factor Productivity (TFP): how much output (of food, for example) can be produced from given inputs (labor and land, for example). So we might expect that the growth rate of TFP in the agricultural sector accelerated in response to all this additional patentability. This is not the case, as the historical data above clearly show: in the US agricultural TFP has been growing at a remarkably constant pace since the end of WWII.¹⁰ More precisely, the average growth rate during [1948-1970] was essentially the same than during [1970-1992], that is about +50%,

and it seems to have marginally slowed down after that. Its oscillations have certainly increased in size, which is hardly a good thing beside being hard to interpret. Some argue that it is “still too early to tell”, an argument we find pretty hard to understand as well as debate: if more than thirty years is not a long enough period for increasing IP protection to bring about its benefits for society, then why bother with patents?



But, perhaps, agricultural TFP is too broad a measure of productivity to reveal the impact of extended patentability in agriculture. To mark the progress of innovation in agriculture one may want to focus on specific species of plants, in which case corn, as a common and important crop, may be a useful case study. We show in the figure below crop yields for U.S. corn, averaged by decade.¹¹



Up until the 1930s yields do not change much – as the specialized literature we mention in the endnotes explains, this turns out to have little to do with lack of innovation, and is due primarily to the fact that as agriculture moved west into poorer climates and soil continuous innovation was required just to maintain crop yields. As the area under cultivation stabilizes, beginning with the 1930s and especially in the 1950s crop yields explode. The primary innovations underlying this explosion are the introduction of improved hybrid varieties that are more responsive to heavy fertilization.

The key point to realize is that the bulk of the growth in yield took place when patents on plant life were impossible or rare and certainly did not apply to corn, which is not asexually reproduced. Indeed, patents on corn hybrids became widespread only after DNA based research began. Pioneer-Hi-Bred International recorded the first such patent on corn in 1974, after most of the growth in yield reported in the figure had already taken place.¹² The large surge in patenting of corn varieties occurred in the period 1974-84 – substantially after the revolution in crop yield was well under way. In fact, the growth rate in corn yield seems to have decreased since the 1980s!

Spanish Hortalezas and Italian Maglioni¹³

Introducing high-tech greenhouse fruits- and vegetables-culture in Almeria, Spain, in the early 1960s was as much an

“economic innovation” as the development of the 286 microprocessor in California, United States, two decades later. It took place through the effort of a large number of completely unknown farmers and in the absence of any patent protection of the business methods and production techniques they created or adopted.

In 1963, Almeria was such a poor and desert area that Sergio Leone went there to shoot his “spaghetti westerns.” The area was no less desolate than Arizona and Southern Utah – but the region was so poor that it was a lot cheaper to make a film there. Shortly after that the first greenhouse, a simple and low-cost pergola-type structure, gave birth to the “Almerian miracle.” The consequences of this innovation are so profound that the results can even be seen from space: the NASA satellite images below, show Almeria before and after the miracle. A picture is really worth more than a thousand words: we cannot imagine a better way of showing how innovation under competition can improve in a short period of time people’s economic conditions.



A similar, if less visually stunning, revolution happened at about the same time in the area around Treviso, Italy, when the members of the Benetton family introduced the “ready-to-color” sweater production process and adopted creative franchising techniques that in a couple of decades transformed a large segment of the clothing sector. Both their original production process and their marketing and distribution methods were rapidly imitated, and improved, first by competitors from the same area and then

from all kinds of far away places. The megastores of *Zara* and *H&M*, attracting hordes of shoppers everywhere in the world, are, until now, the last stage of the innovation-cum-imitation process that *Benetton* started forty years ago in a poor area of the Italian NorthEast.

Each of these economic innovations was costly, took place without intellectual property and was quickly imitated; because of these facts, they not only brought fortune to their original creators, but also led to widespread economic changes in the geographical areas and the economic sectors harboring the initial innovation. In the cases of Almeria and Treviso, the innovation-cum-imitation process was so deep and so persistent that it spilled over to other sectors, leading to a continued increase in productivity that, in a few decades, turned two relatively underdeveloped areas into some of the richest provinces of Spain and Italy, respectively. Indeed, the social value of an innovation is maximized when it spreads rapidly and, by spurring competition, it induces further waves of innovation. Current legislation seems designed to prevent this from happening, thereby greatly reducing the social value of innovative activity.

Financial Markets¹⁴

When you hear the phrase “judge-made law” you probably think of controversial areas, such as abortion and privacy. But the greatest changes in the legal system made by judges, without legislative review or approval, have occurred in the area of patent law. The extension of patent protection to computer software is one example. Another is the patenting of financial securities. Prior to 1998, investment bankers and other firms selling financial securities operated without the “benefit” of intellectual property. The rapid pace of innovation in financial securities prior to 1998 is well documented, for example by Tufano. Tufano estimates that roughly 20% of new security issues involve an “innovative structure.” He reports developing a list of some 1836 new securities over a 20 year period and remarks that this

severely underestimate[s] the amount of financial innovation as it includes only corporate securities. It excludes the tremendous innovation in exchange traded derivatives, over-the-counter derivative stocks (such as the credit derivatives, equity swaps, weather derivatives, and exotic over-the-counter options), new insurance contracts (such as alternative risk transfer contracts or contingent

*equity contracts), and new investment management products (such as folioFN or exchange traded funds.)*¹⁵

Three features of this market particularly deserve note. The first is that innovating in the financial securities industry is very costly, as those creating new securities are highly paid individuals with PhDs in economics, mathematics and theoretical physics. The second is that financial innovations are quickly imitated by competitors. The third, is that there is a pronounced advantage of being first, with the innovator retaining a 50-60% market share even in the long-run. Accounts in the popular press of investment banking in the 1980s, such as Lewis's vivid portrayal, also document that innovation was widespread, despite the complete lack of intellectual monopoly. We are all well aware that, for good or for bad but mostly for the first, the investment banking industry grew tremendously since the late 1970s and until the late 1990s, bringing economic growth to the whole of the nation and increased welfare to millions of consumers. And all of this happened in the complete absence of any form of intellectual monopoly.

This story, sadly, is now over. On July 23, 1998, in *State Street Bank & Trust Co. v. Signature Financial Group, Inc.*, the U.S. Court of Appeals for the Federal Circuit held patentable Signature's "Data Processing System for Hub and Spoke Financial Services Configuration." Prior to this ruling, methods of doing business and mathematical algorithms could not be patented. After this ruling, at least insofar as they are embodied in computer code, business methods and algorithms are patentable, and in particular, it is now possible to patent financial securities: there are now tens of thousands of patented "financial inventions." By this remarkable act of judicial activism the courts extended government granted monopolies to thriving markets, such as those for financial securities, where innovation and competition had gone hand-in-hand for decades. Should this trend not be reversed, we expect that within a decade or so, economists studying the U.S. financial securities industry will be pondering a "productivity slowdown," and wondering what on earth may have caused it. At the current time, about eight years after patents were introduced in the financial and banking sectors, there are no signs that this reallocation of property rights has spurred any wave of new innovations and unprecedented economic growth.

Design

For historical and practical reasons, neither fashion design nor design at large (architecture, furniture, lighting, and so forth) are – better said, were until the other day – effectively protected by patents and copyrights. To be sure, design patents exist, are carefully and scrupulously described in voluminous manuals, and hundreds of design patent applications are filed with the USPTO every month. However, it is quite clear from everyday experience that, in design, imitation is as widespread and common as sand in the Sahara desert.

General design concepts, and even quite particular and specific ones, are de facto not patentable. On the one hand, too many features of the design of a useful object are dictated by utilitarian concerns and, on the other, even very minor ornamental variations are enough to make a certain “design” different from the original one. Practically speaking, what this means is that car companies imitate each other in shaping and styling their cars; architects and engineers do the same with buildings and bridges not to speak of university halls; furniture makers copy each other’s beds, sofas, and coffee tables; lamp makers are continuously coming up with yet another variation on the design of Artemide’s Tizio; all female tailleurs are copycats of Chanel’s ... and so on and so forth.

While design is not all that there is in a coat or in a sofa, it is more and more the factor around which a competitive edge is built. Even the most casual of observers can scarcely be unaware of the enormous innovation that occurs in the clothing and accessories industry every three-six months, with a few top designers racing to set the standards that will be adopted by the wealthy first, and widely imitated by the mass producers of clothing for the not so wealthy shortly after.¹⁶ And “shortly after”, here, means really shortly after. The now world-wide phenomenon of the Spanish clothing company *Zara* (and of its many imitators) shows that one can bring to the mass market the designs introduced for the very top clientele with a delay that varies between three and six months. Still, the original innovators keep innovating, and keep becoming richer.

The pace of innovation, the lack of artificial intellectual monopoly, and the speed and ease of innovation in the fashion design sector is well documented by Kal Raustiala and Chris Sprigman. Once again, a picture is worth a thousand words.



What may be hard to read in the picture is the text of the STEAL ad: it advertises both their own price and the SPLURGE price. The trenchcoat, for example, costs \$1565 from SPLURGE – and \$159 from STEAL.

Similarly in the fine arts, while individual works can be protected by copyright, methods, techniques, styles, and “concepts” cannot be patented. Varnedoe provides vivid documentation of the enormous inventive activity in the modern figurative arts – and the equally rampant imitation that occurred in that field – all in the complete absence of intellectual monopoly. His discussion of widespread experimentation and imitation – by a variety of artists – on the use of perspective is but one example. Finally, consider the enormous growth of the contemporary “lesser brother” of the fine arts, advertising and marketing. Its economic impact is one or two orders of magnitude greater than that of the traditional fine arts sector (although the borders have been getting more and more blurred during the course of the last century) and, also in this sector, neither patents nor copyrights play a relevant role. Still, and almost by definition, if there is a sector of economic activity for which innovation and novelty are the key factors, advertising is certainly the prime candidate.

Sports

When examining the social merit of public institutions, a useful question to ask is whether the same institutions are used in the private sector. For example, government bureaucracies are widely thought to be inefficient. Yet we observe, for example, in the very competitive IT industry that IBM’s internal bureaucratic structure has survived, and indeed thrived, over many years.

Hence, we have to conclude that it is likely that bureaucracies do achieve some socially desirable goals.

We can ask the same question about intellectual monopoly. If intellectual monopoly is a good idea in the public sector as a way of encouraging innovation, is it used in the private sector for that purpose? A case in point is sports leagues. Typically, these leagues have a near absolute power over an entire sport and the rules by which it is played; they also have full control of the commercial part, and stand to benefit from anything that increases demand for their product. Innovation is also important in sports, with such innovations as the Fosbury Flop in high jumping, the triangle offense in basketball, and of course the many new American football plays that are introduced every year, serving to improve performance and provide greater consumer satisfaction. Indeed, the position of the sports leagues with respect to innovation in their own sport is not appreciably different from that of the benevolent social planner invoked by economists in assessing alternative economic institutions.

Given that sports leagues are in the position of wishing to encourage all innovations for which the benefits exceed the cost, they are also in the position to implement a private system of intellectual property, should they find it advantageous. That is, there is nothing to prevent, say, the National Football League from awarding exclusive rights to a new football play for a period of time to the coach or inventor of the new play. Strikingly, we know of no sports league that has ever done this. Apparently, in sports the competitive provision of innovation serves the social purpose, and additional incentive in the form of awards of monopoly power do not serve a useful purpose.

As always, there is an ironic footnote to this triumph of competition: some legal analysts in the United States now argue that the *government* should enforce patents on sports moves.¹⁷

Profits without Patents

Patenting is high and growing by historical standards. The number of total U.S. patents granted yearly has increased 78%, to 113,834 between 1983 and 1995, after which it peaked at 187,015 in 2003 to reach the somewhat lower level of 157,717 in 2005, the last year for which data are available. Similar, albeit quantitatively less pronounced, patterns apply to the EU and Japan. Yet, it turns out, businesses do not regard patents as a significant factor in their decision to innovate. There are two surveys of R&D research directors in which this clearly emerges. This first is the “Yale

Survey” taken in 1987, and the second is the “Carnegie Survey” done in 2000.¹⁸ We focus on the more recent and more detailed Carnegie Survey, but the same facts emerge from the earlier Yale Survey.

The Carnegie Survey reports in 2000 that it received responses from 1118 firms for product innovations, and 1087 for process innovation. The firms were asked whether particular methods were effective in appropriating the gains from an innovation. The table below shows the percentage of firms indicating that the particular technique was effective. The numbers in parentheses are the corresponding figures for the pharmaceutical and medical equipment industries respectively: these are the two industries in which the highest percentage of respondents indicated that patents are effective.

	<i>Product</i>	<i>Process</i>
<i>Secrecy</i>	51.00% (53.57%, 50.97%)	50.59%(68.13%, 49.24%)
<i>lead time</i>	52.76% (50.10%, 58.06%)	38.43%(35.52%, 45.15%)
<i>Complementary manufacturing</i>	45.61% (49.39%, 49.25%)	43.00%(44.17%, 49.55%)
<i>Complementary sales/service</i>	42.74% (33.37%, 52.51%)	30.73%(25.21%, 32.12%)
<i>Patents</i>	34.83% (50.20% ,54.70%)	23.30%(36.15%, 34.02%)
<i>other legal</i>	20.71% (20.82%, 29.03%)	15.39%(16.04%, 22.27%)

This strongly suggests that legal means, including patents, are regarded as the least effective method of appropriating rents. Only about 1/3rd of respondents feel that patents are effective. Secrecy, lead time – the advantage of being first – and complementary manufacturing are rated as the most effective. Indeed, in the case of products, being first is viewed as the most effective means of appropriation. The two exceptional industries, which report a relatively high importance of patents are the pharmaceutical and medical equipment industries. Indeed, these industries, especially the pharmaceutical industry, are often held up as examples of why it is essential to have patents. Yet even in these industries, only about half the respondents rate patents as an effective means of appropriation. Also striking is that in these industries, other means such as lead time, complementary manufacturing and secrecy are regarded as about equally effective as in other industries. Hence, while patents are viewed as more effective in these industries, non-legal means are still quite effective in appropriating rents.

Patent Pools¹⁹

In addition to sports leagues, there is another significant and widespread example of private companies voluntarily relinquishing intellectual property. These are the so-called “patent-pools.” A patent pool is an agreement, generally by a number of businesses in the same industry, to share patents. Although it is sometimes the case that when the pool is set up, a company that has few patents will make a payment to a company that has many patents, once the pool is operating, there is no payment between companies for patents. Any patent by any company in the pool is freely available to any other company in the pool. In some cases patent pools take the form of cross-licensing agreements in which firms agree to automatically cross-license all patents falling into certain categories.

Despite the apparent communistic nature (no “intellectual property” for the in-group) of these arrangements, patent pools have been widely used.

In the United States, in a number of industries, processes of “collective invention” were implemented by means of patent pools. Note that in some cases, patent pools were created after having experienced phases of slow innovation due to the existence of blocking patents. In the 1870s, producers of Bessemer steel decided to share information on design plants and performances through the Bessemer Association (a patent pool holding control of the essential patents in the production of Bessemer steel). The creation of this patent pool was stimulated by the unsatisfactory innovative performance of the industry under the “pure” patent system regime. In that phase, the control of essential patents by different firms had determined an almost indissoluble technological deadlock. Similar concerns over patent blockages led firms operating in the railway sector to adopt the same expedient of semi-automatic cross-licenses and knowledge sharing.²⁰

At the current time, patent pools are generally mandatory for participants in recognized standard setting organizations such as the International Telecommunications Union and American National Standards Institute. Large microprocessor corporations, such as IBM, Intel, Xerox and Hewlett-Packard engage in extensive cross licensing. Important computer technologies,

including the MPEG2 movie standard and other elements of DVD technology are part of a patent pool.

Given the widespread willingness of large corporations to voluntarily relinquish patent protection through cross-licensing and patent pools, you might wonder why eliminating patents would even be necessary. Unfortunately, while patent pools eliminate the ill effects of patents within the pool – they leave the outsiders, well, outside. If the existing firms in an industry have a patent pool, then the prospects of a newcomer entering are bleak indeed. So while patent pools may give a strong indication that patents are not a terribly good idea, and that competition has many benefits – they do not unfortunately undo some of the most important harm of government enforced monopoly – that of preventing entry into an industry.

In fact, the widespread existence of patent pools in industries with a well-established set of mildly competing insiders is wonderful evidence of two important things at the same time. First, that patents are inessential to compensate individual firms for the fixed cost of invention. Second, that patents are a powerful tool for establishing monopoly power and preventing entry by potential competitors.

Comments

A good, if dated, and relatively succinct survey of the history of technology is in Derry and Williams [1960]. A quicker-to-find one is, as usual, the entry “history of technology” in Wikipedia. A classical account of the view that the Industrial Revolution would, at least, have been greatly retarded had not patents been available in England at the end of the eighteenth century can be found in North [1981]. A recent, and quite balanced, rendition of this point of view is in the recent book by Gregory Clark [2007], which also contains various other references. For one of the many extreme applications of this claim to contemporary issues, see Nwokeabia [2002]: a UN Economic Commission for Africa’s report claiming that the industrial revolution missed Africa mainly because the latter did not adopt the European system of patents.

Should the curious reader want to embark on a more complete survey of the history of patent laws, the Wikipedia piece of the Statute of Monopolies is as good, and free, starting point as any we know of outside the specialized literature. The technical literature on the life-cycle of industries is very large. Still, only a few authors seem to have paid attention to the correlation between competition and the degree of technological innovation on the one hand, and obsolescence and demand for monopolistic restrictions on the other; Braguinsky et al [2007] is one recent and excellent exception containing references to the few earlier authors that had mentioned aging industries’ rent-seeking as an explanation of patents and their dynamics.

Notes

¹ The statement that the software industry is currently much less innovative than at its inception may appear odd to fans of *World of Warcraft* and of “major” innovations such as Massively Multiplayer Online Role-Playing Games (MMORPGs). Still, this is the very robust, if controversial, finding of most empirical studies carried out by the experts in this area. Incredulous readers should visit James Bessen’s site at <http://www.researchoninnovation.org/online.htm> for starters and then continue on with the references therein. Alternatively, all one needs to do is to enter “software patents innovations” in Google and then click happily away.

² The complete text of the Statute of Monopolies can be found in the Appendix to Price [2006]. The quotation is in page 138.

³ Ivi, p. 135.

⁴ Stigler [1956], p. 275.

⁵ Ivi, p. 274. Stigler argues against the Schumpeterian view that monopoly is a good thing because it brings forth innovation. As indicated by the quotations in the text, his view, like ours, is that plentiful innovation occurs under competition.

⁶ Nuvolari [2004a], p. 354.

⁷ That Trevithick did not patent his invention is documented in Rowe [1953].

⁸ The Cornwall mining industry experience is studied in Nuvolari [2004a,b] where data on the fuel efficiency, the “duty,” of steam engines can be found. An analogous episode is that of Cleveland’s iron producers – Cleveland, U.K., not Ohio – deftly documented and discussed in Allen [1983]. Around the middle of the nineteenth century they managed to fiercely compete while allowing technical information on the development and improvements of the blast furnace to flow freely from one company to the other. Firms in industries involving iron and coal, apparently, are prone to practicing invention and innovations without patents and intellectual monopoly protection; Adams [1966] tells the story for the big-steel industry post WWII.

⁹ Historical analyses of the agricultural sector before the advent of patenting can be found in McClellan [1997], for the US, and Campbell and Overton [1991], for Europe. Detailed studies of the “nineteenth and early twentieth century [...] stream of biological innovations” in US agriculture are, for example, Olmstead and Rhode [2002], for grain and cereals, Olmstead and Rhode [2003], for cotton, and Barragan Arce [2005], for fruit trees. Olmstead and Rhode [2003] also document how, in the cotton farming sector, “inventors, during an early phase of the product cycle, actually encouraged consumers to copy and disseminate their intellectual property.”

¹⁰ The estimates of agricultural TFP 1948-2002 are from the USDA.

¹¹ Crop yield data is from the National Agriculture Statistics Service.

¹² The information on patents of corn hybrids is from Urban [2000].

¹³ The history of “maglioni” in the Italian North East comes mostly from the first hand experience of one of us, a chronology of Benetton is at www.musedelapub.org. The satellite images of Almeria are from NASA and are reproduced widely, for example at www.iberianature.com. More detailed facts are offered in Costas and Heuvelink [2000]. In case you doubt our statement that Almeria’s horticulture is probably the most efficient agricultural enclave in the world, see www.edis.ifas.ufl.edu. One of the many stories of innovation with imitation and competition we have not told, but that should be told, is that of the extremely successful Taiwanese machine tool industry, an account of which is in Sonobe, Kawakami and Otsuka [2003]. Quoting only this, though, amounts to doing an injustice to so many others ... but even books have limited capacity.

¹⁴ Innovation in the financial industry prior to patents is documented in two papers by Tufano [1989, 2003] and by a recent paper by Herrera and Schroth [2004]. A less academic view of the investment banking industry can be found in Lewis [1989]. The business practices patent dates to the 1998 Court of Appeals for the Federal Circuit decision in “State Street Bank v. Signature Financial.” In one of the most dramatic examples of judicial legislation, they found that there is no prohibition in U.S. law on patents for business methods as long as they are new, useful, and non-obvious. This is mentioned in Ladas and Parry [2003] who also provide a useful summary of key developments in U.S. Patent Law. The State Street Bank Case is also discussed at www.gigalaw.com.

¹⁵ Tufano [2003]. The quote is from page 7 of the original working paper available on line at the author’s site, http://www.people.hbs.edu/ptufano/fininnov_tufano_june2002.pdf

¹⁶ The best empirical treatment of the fashion industry is Raustiala and Sprigman [2006], from whom we took the photographs of SPLURGE versus STEAL. The paper contains a great many similar examples. One of us just came back from his skiing vacation noticing this: the skiing industry innovates at a dramatic pace, essentially at the same pace as the fashion industry, and it is, like the latter, de-facto free of any kind of effective patent protection. Do not get us wrong: each new gadget or shape or edge-cut is duly patented by the firm that gets first to the patent office. Still, every year the twenty or so companies that produce skis come up with new models and ... they are all practically identical! Can you tell which firm “invented” the idea of a carving ski? If it were patented – we could not find evidence either way – it clearly did not matter as everyone copied it rather quickly. A patent (European Patent EP1208879) apparently exists, but no one seems to care much. The very same story applies to the dozen or so firms competing in the ski-boots sector.

A theoretical treatment of the fashion cycle can be found in Wolfgang Pesendorfer [1995] whose model is perfectly consistent with competitive creation.

¹⁷ A proposal for patenting sports moves is Kukkonen [1998]. While it may be that sports leagues do not give monopolies for fear that exclusive rights will give one team too much of an advantage, they can also have optional or mandatory licensing to allow the good ideas to spread.

¹⁸ The “Yale Survey” is described in Levin et al [1987] and Klevorick et al [1995]. “The Carnegie Survey” is described in Cohen et al [2000].

¹⁹ Most of the information about patent pools is from Shapiro [2001].

²⁰ Nuvolari [2004a], p. 360.