Chapter 4: Innovation Without Patents

As a matter of theory, intellectual monopoly appears unnecessary. As a matter of fact, we have seen numerous examples showing the frenetic pace of creation in the absence of copyright. As the theory suggests, creations such as literature, music, movies, and news thrive in the absence of copyright. So perhaps copyright 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 marvelous machines, drugs and ideas we are surrounded with if not for the beneficent force of patent law? Can we risk the foundation of our prosperity and growth by eliminating patents? Guess what – we are going to argue that without patents we would have more, not less, marvelous machines and inventions. We are going to observe that patent law is largely the unwelcome consequence of competitive innovation and poor legislation, and not the source of innovation at all.

It may not come as a shock to anyone that computer software and financial securities are scarcely the only industries in which patents are less than essential to innovation. In fact, most successful industries have followed the same pattern: no intellectual property at the pioneering stage when innovations come pouring in and better and cheaper goods are invented with high frequency; desperate scrambling for the pork that intellectual property provides when the creative reservoir runs dry. Because this is true in every well established sector, from cars to electricity, from chemical and pharmaceutical to textiles and computers, we will try to make the point by looking at some unusual, less obvious experiences. We will show how innovation thrives without patents in sectors where imitation is cheap and where there are a lot of fiercely competing companies.

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, fortunately this was an exceptional provision. It was the English in 1624 who really pioneered patent law with the *Statue of Monopolies*. Notice that at that time the euphemism of intellectual "property" had not yet been introduced – that it was a monopoly

right and not a property right that was being granted was not in question. The *Statue of Monopolies* 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, revised and improved 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 other were forced to learn. Insofar as the British system of patent was helpful in inducing the industrial revolution, it is likely that it was the limitation placed by these laws on the arbitrary power of government to block and monopolize innovation that was important.

After the British legislative innovations of 1624 and 1710, imitation proceeded rather slowly in the rest of Europe: for good or ill the transmission of ideas does take 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. 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 were not 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.

During the last twenty-five or thirty years the "everything should be patented" trend has set in, especially in the United State.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 1988. In most of the rest of world they still cannot be patented.

The list of industries that were born and grew in the absence of intellectual property protection is almost boundless. 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 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) cannot be patented. Simultaneously, the copyright on scientific articles enriches a handful of encroached and inefficient publishers instead of the scholars who wrote the articles.

We are getting personal, so let us appeal to a less partial authority. While a minority among economists, we are not alone 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*.

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.*

Since 1955 we can add to this list such modern innovations as Ray Kroc's fast-food franchise, the 24-hour convenience store, the suburban shopping mall, franchise-everything (from coffee to hairdressing), and online commerce.

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) and he faces a high risk of failure. The cost of imitation is much less – it is known 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" confirms 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, and usually succeeds. Such rent-seeking legislation in the emigration industry we call "immigration and naturalization restrictions" or "quotas".

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 experience between the Portuguese/Spanish settlement of Central/South America, and that of the English settlement 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.

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 is a widespread belief that the Industrial Revolution took place when it took place (allegedly, sometime between 1750 and 1850) and where it took place (England) because patents giving inventors a prolonged 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 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 and bankrupting 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, phyrric, victory of the two monopolists. Phyrric, 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 when the Boulton and Watt patent had long 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." 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. It happened to be as efficient as the Watt's, but much more amenable to improvement. This triggered a long and extremely successful period of "collective 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 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 is 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 the innovation, and engineers having signed away the right to monopolize their invention, instead profiting from their fees and by the advertising value of publicizing their innovations. Indeed in many respects, this collaborative, competitive mine engine improvement is similar to modern day open source software.

The Industrial Revolution period is, indeed, 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 many anecdotes, the story of Eli Whitney is particularly instructive. Born in Westboro, Massachussets, on Dec. 8, 1765, Whitney graduated from Yale College in 1792. By April 1793, he had designed and constructed the cotton gin, a machine that automated the separation of cottonseed from the short-staple cotton fiber. Very much like the 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 wasted 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, and receiving little compensation for their strenuous efforts.

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. 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 sell 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.

Agriculture

Among economists the reaction to the idea that economic progress is the fruit of competition is bimodal. 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 seemed to follow straightforwardly from the assumptions. Specialists working in the areas of innovation, economic growth, and industrial organization long steeped in the conventional wisdom are certain that the idea cannot possibly be correct, although uncertain as to why not. The exception are specialists in agricultural economics, who react with neither boredom nor rage. It turns out that until the early 1970s innovation in agriculture has flourished without much in the way of protection from intellectual monopoly – and that agricultural economists are well aware of this. 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.

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."

Shortly afterwards, the discovery of Mendel's law – imagine a world in which Mendel had managed to patent his law, a very likely possibility 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

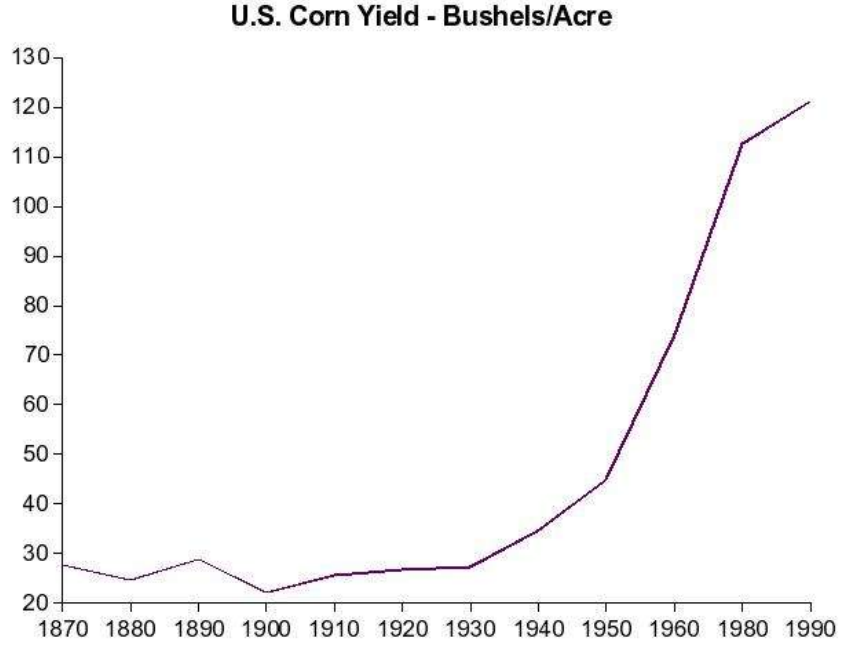
its "creation" was equivalent therefore to the invention of a new mechanical tool. Notice an important detail: during the many decades it took to buy monopoly protection from Congress, the breeding industry was, literally, blossoming and growing under conditions of competition and without intellectual 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 get the law changed.

There is a basic pattern here, that is ubiquitous in the life cycle of most new industries. Innovative and dynamic industries emerge either because intellectual monopoly is not present or to bypass it. 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 grow more powerful and the opportunities for further innovation diminishes the value of monopoly protection for the insiders increases, lobbying efforts multiply and, unfortunately, 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 mark the progress of innovation in agriculture, corn as a common and important crop makes a useful case study. We show in the figure below crop yields for U.S. corn, averaged by decade.



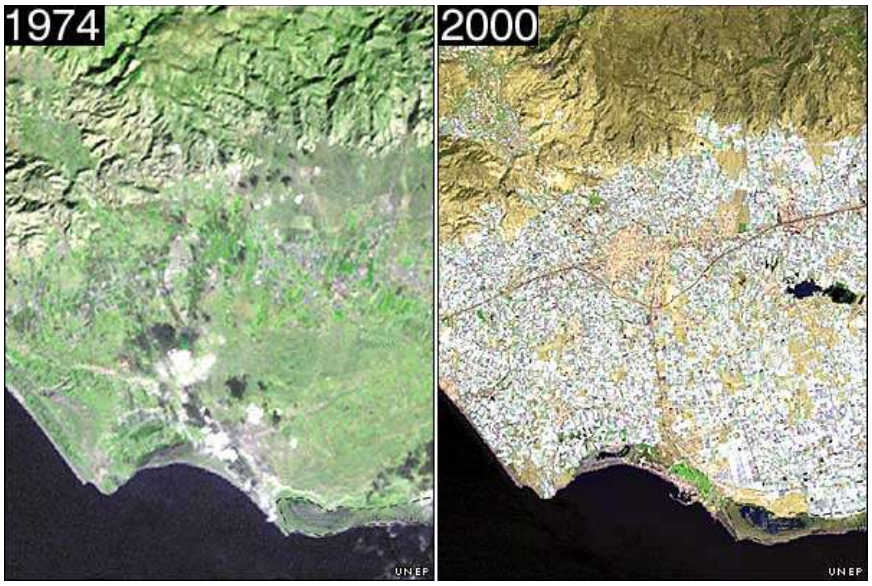
Up until the 1940s yields do not change much – this turns out to have little to do with lack of innovation, and is due primarily to the fact that as agriculture moved west into poorer climates and soil continuous innovation was required just to maintain crop yields. As the area under cultivation stabilizes, beginning with the 1940's 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. Indeed, as we have observed 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. 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.

Spanish Hortalezas and Italian Maglioni

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 as poor and desert as anything can be, so much so, that Sergio Leone went there to shoot his "spaghetti westerns": it looked like the desert of Arizona and Southern Utah, but it was a lot closer and cheaper. Then the first greenhouse, a simple and low-cost pergola-type structure, gave birth to the "Almerian miracle." The physical change wrought in Almeria is graphically illustrated in the NASA satellite images below, showing the landscape before and after.



Whoever the first few innovators were, they were rapidly and widely imitated by many other small farmers, but this did not apparently reduce their drive to get there first. In fact, the innovators of Almeria were, most certainly, imitators of the long established tradition of family "huertas" in the nearby region of Murcia. The difference being that, in Almeria, better land was available, wages were lower, and the sudden competitive drive that reciprocal imitation spurned, led to gigantic efficiency gains. Over a period of forty years, this competition brought 100,000 acres of land under cultivation, and it built today's most productive and successful agricultural enclave in all of Europe, and probably of the world.

A similar 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.

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 Markets

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.)*

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.

The story, sadly, is not 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.

Design

For historical and practical reasons, neither fashion design nor design at large (achitecture, furniture, lighting, and so forth) are 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, mostly for the benefit of the lawyers that take care of filing those applications. 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 because, 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 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. 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.

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 – 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.

Patent Pools

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.*

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.

Profits without Patents

Patenting is high and growing by historical standards. The total number of U.S. patents has increased 78%, to 114,241 between 1983 and 1995. 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. 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.

	Product	*Process*
secrecy	51.00% (53.57%, 50.97%)	50.59%(68.13%, 49.24%)
lead time	52.76% (50.10%, 58.06%)	38.43%(35.52%, 45.15%)
complementary manufacturing	45.61% (49.39%, 49.25%)	43.00%(44.17%, 49.55%)

complementary sales/service	42.74% (33.37%, 52.51%)	30.73%(25.21%, 32.12%)
patents	34.83% (50.20% ,54.70%)	23.30%(36.15%, 34.02%)
other legal	20.71% (20.82%, 29.03%)	15.39%(16.04%, 22.27%)

The most striking fact is that legal means, both patents and other legal means 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.

Also of interest are the reasons for which patents are considered valuable by business firms. With 755 product, and 674 process respondents, the Carnegie Survey reports the following percentage of respondents indicating the particular motivation for seeking a patent.

	Product	***Process***
measure performance	5.75%	5.04%
licensing revenue	28.27%	23.25%
use in negotiations	47.38%	39.96%
prevent suits	58.77%	46.50%
prevent copying	95.81%	77.61%
blocking	81.81%	63.58%
enhance reputation	47.91%	34.03%

Notice that licensing revenue – the sale of ideas, is relatively unimportant. The achievement of monopoly power through the prevention of copying is quite important. But notice also the importance of pure rent-seeking: use in negotiations, preventing

suits, and blocking competition have a cumulative score of 187.96% for product innovations and 150.04% for process innovations. This can be taken as a crude indication that the amount of loss due to rent-seeking attributable to patents exceeds the amount of additional monopoly profit generated – not exactly a strong reason for a patent system.

Concluding Remarks

There are several examples that do not fit neatly into the category of innovation without intellectual monopoly because of a strong presence of government subsidies, but these examples are too dramatic to be bypassed completely. The first is progress in basic science. Basic scientists have never been entitled to a monopoly on their research; in modern times this research is heavily subsidized, but Newton, Darwin, and Einstein received neither intellectual monopoly, nor government subsidy – and there are of course many other less prominent examples. As always, there is a fly in this ointment. Traditionally university and government subsidized research did not benefit from intellectual monopoly. Despite the absence of any apparent lack of university research, or adoption in industry, recently public policy in the United States, under the guise of so-called "public-private partnership," has been to encourage universities to apply for intellectual monopolies even for government subsidized research.

Finally, the remarkable pace of innovation during the Second World War should not escape notice. In 1940, the British government was able to employ 1914 style biplanes to help sink the battleship Bismarck. By 1945 the Germans deployed jet aircraft, and both cruise and ballistic missiles. Developments in electronics and cryptography were equally dramatic, and no development perhaps so dramatic as that of the fission bomb. Intellectual monopoly clearly played no role in these developments, and indeed the environment of collaboration (within the combatant nations) possible in its absence seems to have had a key role in the dramatic acceleration of technological progress. While government subsidy was significant, any reading, for example, of the history of the Manhattan project, or Bletchley Park, makes clear that the enormous effort provided by individual scientists was not a response to an expectation of financial reward, either from the government or private sector.

But the example of the Second World War is important for a second reason. We often think of government subsidy as an alternative to intellectual monopoly – but in the Second World War,

the competition between governments illustrates clearly how a competitive market produces innovation in the absence of intellectual monopoly. Take the fission bomb as an example. The potential innovators were not individuals, but rather the different governments – most importantly the U.S., Nazi Germany, and the Soviet Union. The country that first succeeded in inventing the fission bomb obviously was not going to be granted an exclusive legal monopoly by its rivals, so the conditions were those of competition. Imitation was a major concern – and the evidence suggests that the cost of being second – by the Soviets – was substantially less than the cost of being first, and the cost of being third (Britain), fourth (France) and fifth (China) – less yet. In the absence of intellectual monopoly, trade secrecy played an important role in creating incentives for innovation. However, despite heroic efforts – violation of trade secrecy in this case carrying with it the death penalty – it took only four years for the Soviet Union to follow the example of the U.S. – quite a bit less than the seventeen years granted under international patent law at that time.

Never-the-less there was a huge advantage in being first. At the end of the war with Germany, the U.S. and its western allies were heavily outnumbered by the Soviets in Europe – and the Soviets had better tanks and shorter supply lines. The fear of Soviet invasion of Western Europe was sufficiently high that it has often been argued that a rationale for Truman exploding the second bomb at Nagasaki was a signal not to Japan, but to the Soviet Union. Regardless, the fact that the U.S. was first certainly played a significant role in assuring the freedom of Western Europe after the war. The advantage of being first – even though it lasted for only a short while – provided incentive for the most massive research project ever undertaken; the Manhattan project cost over a hundred times more than the most expensive movie or pharmaceutical research project ever. Yet, the incentives that induced this huge public investment were not different from those that arise in private competitive markets: innovate or get beat by your competitors and perish.

Notes

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.

Stigler [1956] 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.

A classical account of the view that the Industrial Revolution would, at least, have been greatly retarded had not patents been available and enforced in England at the end of the eighteenth century can be found in North [1981]. The Cornwall mining industry experience is studied in Nuvolari [2004]. 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 improvments of the blast furnace to flow freely from one company to the other. That Trevithick did not patent his invention is documented in Rowe [1953]. A good and relatively succinct survey of the history of technology is in Derry and Williams [1960].

An 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." Crop yield data is from the National Agriculture Statistics Service, information on patents of corn hybrids from Urban [2000].

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.museedelapub.org. The satellite images of Almeria are from NASA and are reproduced widely, for example at www.iberianature.com. More detailed facts are 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, check out 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.

Innovation in the financial industry prior to patents is documented in two papers by Tufano [1989, 2002] 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.

Wolfgang Pesendorfer [1995] models the fashion cycle along lines that are perfectly consistent with competitive creation. Innovation in the figurative arts is discussed, in Varnedoe [1990].

A proposal for patenting sports moves is Kukkonen [1998]. The quotation about the Bessemer patent pool is from Nuvolari [2004]. Most of the remaining information about patent pools is from Shapiro [2001].

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]. A study of the impact of the increased role of universities in patent and other forms of intellectual monopoly can be found in Colyvas et al [2002].