Chapter 8: Does Intellectual Monopoly Increase Innovation?

What we have argued so far may not sound altogether incredible to the alert observer of the economics of innovation. What have we shown, after all? That thriving innovation has been and still is commonplace in the absence of intellectual monopoly and that intellectual monopoly leads to substantial and well-documented reductions in economic freedom and general prosperity. However, while expounding the theory of competitive innovation, we also recognize that under perfect competition, some socially desirable innovations will not be produced. When this is the case, monopoly power may generate the necessary incentive for the putative innovator to introduce socially valuable goods. And the value for society of these goods could dwarf the social losses we have documented. So, by our own admission, it is a theoretical possibility that intellectual monopoly could, at the end of the day, be better than competition. But does intellectual monopoly actually lead to greater innovation than competition?

From a theoretical point of view, the answer is murky. In the long-run, intellectual monopoly provides increased revenues to those that innovate, but also makes innovation more costly. Innovations generally build on existing innovations. While each individual innovator may earn more revenue from innovating if he has an intellectual monopoly, he also faces a higher cost of innovating: he must pay off all those other monopolists owning rights to existing innovations. Indeed, in the extreme case when each new innovation requires the use of lots of previous ideas, the presence of intellectual monopoly may bring innovation to a screeching halt.

Further, theoretical considerations also suggest that the response of innovation to the strengthening of intellectual monopoly is not uniform over time. In the short-run – for example, immediately after the first introduction of legislation allowing for patents – we would expect innovation to increase, as the revenues from innovating go up, but costs will not increase until some time in the future when many ideas have been patented. Strikingly – from a theoretical point of view – it is possible that, in the short-run introducing patents leads to more innovation and eliminating patents after they have been in place for a while – by reducing the cost of innovation – increases innovation as well.

By the same token, theory suggests that small countries with low IP protection should witness a surge in the inflow of IP-related investment after their IP protection is increased, as they capture investments from other countries where intellectual monopoly is protected less. The latter unfortunately appears to have gone beyond a mere theoretical possibility to become an appropriate description of current policy trends, which is why we place it at center stage in our discussion of TRIPS later in the book.

The issue, then, is again the one we posed at the outset: does monopoly really lead to more innovation, on average, than competition? Theory gives an ambiguous answer, so let's look at evidence, supported by a bit of statistical common sense.

What is the evidence? Given the continued extension of patent protection to new areas – business practices and computer software, for example – one might hope that there is strong evidence that the introduction of patent protection has lead to a substantial increase in innovation in recent years. These hopes, alas, are not to be fulfilled: It is already apparent that the recent explosion of patents in the U.S., the E.U. and Japan, has not brought about anything comparable in terms of useful innovations and aggregate productivity. Nevertheless, one may claim that it is too early to judge and that the process of progressive extension of intellectual monopoly to almost every area of human endeavor has not yet run its full course. Beneficial results will come, but in due time, so be patient and let the tide of intellectual monopoly run its course. To us, as it should be clear by now, the tide of intellectual monopoly resembles more those of destructive tsunamis or hurricanes than the benevolent one supposedly lifting all boats. Hence, instead of letting it run its malevolent course and then observe the devastation from some helicopter flying high over the scene, we would rather learn now from the past and begin erecting strong levees. Indeed, the historical evidence provides little or no support for the view that intellectual monopoly is an effective method of increasing innovation.

Copyright and Music in the 18th Century

The effect of copyright is difficult to analyze because it is hard to get reliable data prior to the 19th century. Copyright was fairly ubiquitous across Europe early in the 19th century, and its term there has changed little since then.

The one exception turns out to be in the case of classical music. Copyright was unknown in the world of music until around the end of the 18th century. As a result, a large proportion of

classical music, still today accounting for about 3% of all music sales but, obviously, a much larger portion of music production until late in the 19th century, was produced without the benefit of copyright protection.

In this case, as in others, England was the pathbreaker. The Statute of Anne did not cover printed music until a case filed by Johann Christian Bach lead, in 1777, to a ruling that allowed for the extension. It took various additional decades for the copyright logic to spread to the rest of Europe, which provides us with an interesting natural experiment.

Think for a moment of the history of European music between, say, 1780 and 1860-1870 as, by the latter date, music had become copyrightable all over Europe. Which countries would you list in the "top three" producers of music during that period? Would the United Kingdom make that list? Would you agree or disagree with the following statement: "After 1770, the quality and quantity of music produced in the UK increased substantially"? Make up your personal list of the top ten music composers of that period, how many are British or worked there? By the way, while evaluating the results of this small experiment do keep in mind that England was the most economically advanced country in Europe all along that period, and that general, and in particular musical, literacy was more widespread there than in continental Europe. Here is a quotation about a similar thought experiment; it comes from an unsuspecting source as the author, Professor Scherer, is (or at least was) a strong supporter of intellectual property.

> *The evolution of copyright from an occasional grant of royal privilege to a formal and eventually widespread system of law should in principle have enhanced composers' income from publication. The evidence from our quantitative comparison of honoraria received by Beethoven, with no copyright law in his territory, and Robert Schumann, benefiting from nearly universal European copyright, provides at best questionable support for the hypothesis that copyright fundamentally changed composers' fortunes. From the qualitative evidence on Giuseppe Verdi, who was the first important composer to experience the new Italian copyright regime and devise strategies to derive maximum advantage, it is clear that copyright could make a substantial difference. In the case of Verdi, greater remuneration through full exploitation of the copyright system led perceptibly to a lessening of composing effort.*

Professor Scherer also exploited the variations between European countries copyright law regarding music to conduct a natural experiment. He compared the average number of composers born per million population per decade in various European countries. Turning first to England, he considers the precopyright period 1700-1752, and the post copyright period 1767-1849. As controls he looks also at what happened in Germany, Austria and Italy in which there was no change in copyright during this period.

	Pre	*Post*	*Ratio*
UK	0.348	0.140	0.40
Germany	0.493	0.361	0.73
Italy	0.527	0.186	0.35
Austria	0.713	0.678	0.95

We see that the number of composers per million declined everywhere, but it declined considerably faster in the UK after the introduction of copyright than in Germany or Austria, and at about the same rate as Italy. So there is no evidence here that copyright increased musical output.

However, the evidence is mixed, because the same experiment in France is more favorable to copyright. In France the precopyright period is 1700-1768, and the post copyright period is 1783-1849

	Pre	*Post*	*Ratio*
France	0.126	0.194	1.54
Germany	0.527	0.340	0.65
Italy	0.587	0.153	0.31
Austria	0.847	0.740	0.86

Here we find that France, where copyright is introduced, the number of composers per million increased substantially more than in other countries. This should be noted, as it is pretty much the only piece of evidence supporting the idea that copyright increased classical music production one can find in the literature.

Looking more broadly at the entire European situation Scherer himself, and we with him, find it difficult to conclude that

copyright law was a significant factor in determining the amount of musical composition taking place.

Patents and Innovation in the 19th Century

Kenneth Sokoloff, together with Naomi Lamoreaux and Zorina Kahn examined the role of patents in the U.S. in the 19th and early 20th century. In 1836 the U.S.

> *instituted an examination system under which, before granting patents, technical experts scrutinized applications for novelty and for the appropriateness of claims about invention. This procedure made patent rights more secure by increasing the likelihood that a grant for a specified technology would survive a court challenge, and may also have provided some signal about the significance of the new technology. Thereafter, both patenting and sales of patent rights boomed.*

Subsequently, they document the development of an elaborate system of trading ideas. This includes both specialized intermediaries and journals advertising the existence of patents. Some of these intermediaries not only assisted inventors in obtaining patents, but in some cases seem to have acted as modern day venture capitalists, providing start up funding to put ideas into production.

As a study of innovation in the late 19th and early 20th century, this research is of great interest. It does not, however, provide much evidence that the patent system promotes innovation. It should be observed that the institutional change that led to the booming of patenting and the sales of patent rights was to make it more difficult to get patents – quite the opposite of modern institutional changes. In addition, while this research makes it clear that the number of patent agents and inventors making use of their services boomed, they also document that an important portion of the services were to assist inventors in getting patents, and in navigating the thicket of existing patents – socially wasteful activities that would be unnecessary in the absence of a patent system.

One important difficulty is in determining the level of innovative activity. One measure is the number of patents, of course, but this is meaningless in a country that has no patents, or when patent laws change. Petra Moser gets around this problem by examining the catalogs of innovations from 19th century World Fairs. Of the catalogued innovations, some are patented, some are

not, some are from countries with patent systems, and some are from countries without. Moser catalogues over 30,000 innovations from a variety of industries.

> *Mid-nineteenth century Switzerland [a country without patents], for example, had the second highest number of exhibits per capita among all countries that visited the Crystal Palace Exhibition. Moreover, exhibits from countries without patent laws received disproportionate shares of medals for outstanding innovations.*

Moser does, however, find a significant impact of patent law on the direction of innovation

> *The analysis of exhibition data suggests that patent laws may be an important factor in determining the direction of innovative activity. Exhibition data show that countries without patents share an exceptionally strong focus on innovations in two industries: scientific instruments and food processing. At the Crystal Palace, every fourth exhibit from a country without patent laws is a scientific instrument, while no more than one seventh of other countries innovations belong to this category. At the same time, the patentless countries have significantly smaller shares of innovation in machinery, especially in machinery for manufacturing and agricultural machinery. After the Netherlands abolished her patent system in 1869 for political reasons, the share of Dutch innovations that were devoted to food processing increased from 11 to 37 percent.*

Moser then goes on to say that

> *Nineteenth-century sources report that secrecy was particularly effective at protecting innovations in scientific instruments and in food processing. On the other hand, patenting was essential to protect and motivate innovations in machinery, especially for large-scale manufacturing.*

Evidence that secrecy was important for scientific instruments and food processing is provided, but no evidence is given that patenting was actually essential to protect and motivate innovations in machinery. Notice that in an environment in which some countries provide patent protection, and others do not, bias caused by the existence of patent laws will be exaggerated. Countries with

patent laws will tend to specialize in innovations for which secrecy is difficult, while those without will tend to specialize in innovations for which secrecy is easy. This does not mean that elimination of patent protection in all countries would have the same effect.

It is interesting also that patent laws may reflect the state of industry and innovation in a country

> *Anecdotal evidence for the late nineteenth and for the twentieth century suggests that a country's choice of patent laws was often influenced by the nature of her technologies. In the 1880s, for example, two of Switzerland's most important industries chemicals and textiles were strongly opposed to the introduction of a patent system, as it would restrict their use of processes developed abroad.*

The 19th century type of innovation – small process innovations – are of the type for which patents may be most socially beneficial. Despite this and the careful study of economic historians, it is difficult to conclude that patents played an important role in 19th and early 20th century innovation.

Intellectual Property and Innovation in the 20th Century

A number of scientific studies have attempted to examine whether introducing or strengthening patent protection leads to greater innovation. We have identified seventeen economic studies that have examined this issue empirically. The executive summary: these studies find weak or no evidence that strengthening patent regimes increases innovation; they find evidence that strengthening the patent regime increases … patenting! They also find evidence that, in countries with initially weak IP regimes, strengthening IP increases the flow of foreign investment in sectors where patents are frequently used.

Authors	*Years*	*Country*	*Industry*
Arundel	Many	Many	Many
Bessen and Hunt	1980-1996	U.S.	Software
Gallini	1980s	U.S.	Many
Hall and Ham	1980-1994	U.S.	Semiconductor
Hall an Zeidonis	1979-1995	U.S.	Semiconductor
Jaffe	Many	Many	Many
Kanwar and Evenson	1981-1990	Many	Aggregate

Kortum and Lerner	1980-2000	U.S.	Many
Lanjouw	1990s	India	Pharmaceutical
Lanjouw and Cockburn	1975-1996	India	Pharmaceutical
Lerner-1	1850-2000	Many	Many
Lerner-2	1971-2000	U.S.	Financial
Licht and Zoz	1992	Germany	Many
Lo	c. 1986	Taiwan	Many
Park	1987-1995	OECD	Many
Qian	1979-1999	Many	Pharmaceutical
Sakakibara and Branstetter	1988-1995	Japan	Many
Scherer and Weisbrod	1970s	Italy	Pharmaceutical

The studies by Arundel, Gallini and Jaffe are actually surveys of earlier empirical work, each one of them focusing on particular issues, data sets, or methodological approaches. We read

> *The results suggest that there is little need to strenghten patent protection since alternative appropariation methods are available and widely prefered. Instead, stronger patent protection could be leading to undesirable 'second-order' effects such as the use of patents to block competitors.* [Arundel]

After failing to find a single study claiming that innovation increased as a consequence of the strengthening of U.S. patent protection in the 1980s, Gallini writes

> *Although it seems plausible that the strenghtening of U.S. Patents may have* ***contributed to the rise in patent*** *over the past decade and a half, the connection has proven difficult to verify. ... The explanation more favorable toward patents is that recent reforms deserve some attribution for the dramatic rise in patents (and innovation), but sufficient time has not passed to capture this effect empirically.* [Emphasis added.]

Pretty much for the same reasons, that is to say: the absence of any empirical evidence that more IP and more patents mean more innovations and higher productivity, Jaffe's opening punch line is

> *... despite the significance of the policy changes and the wide availability of detailed data relating to patenting, robust conclusions regarding the empirical consequences for technological innovations of changes in patent policy are few.*

Adding, in the conclusion that

> *There is widespread unease that the costs of stronger patent protection may exceed the benefits. Both theoretical and, to a lesser extent, empirical research suggest this possibility.*

Several of these studies examine or are influenced by the upswing in patenting that occurred in the United States in the mid-1980's. This upswing followed the establishment of a special patent court in the U.S. in 1982; it turned into an explosion in the roaring 1990s, paralleling the dotcom stock market bubble, but it did not stop after that bubble burst. In 1983 in the U.S. 59,715 patents were issued against 105,704 applications; by 2003, 189,597 patents are issued against 355,418 applications. In twenty years, the flow of patents roughly tripled.

Kortum and Lerner focus specifically on the surge in U.S. patents, and make no claim as to if this means more or less productivity growth. By examining how the composition of patent applications changed they argue that this surge in patenting reflects increased innovation – not merely taking advantage of greater laxity in patent laws. They also argue, though, that this increased innovation was not due to changes in the structure of patent law and intellectual property protection, but rather to a better management of R&D expenditure at the firm level.

The authors who find the strongest effect on innovation of increased patent protection are Kanwar and Evenson, and Lo. The latter examines the 1986 reform in Taiwan, while the former use time series data from a cross section of countries to regress R&D as fraction of GDP on various variables including a qualitative measure of IP protection. Both sets of results are worth examining a bit more closely than the rest.

Lo finds increased innovation by Taiwanese inventors as measured by R&D expenditure and by the number of U.S. patents they were awarded. However, given the worldwide surge in U.S. patents about this time and the fact that the number of Taiwanese patents awarded to these same inventors did not much increase, we

can neither reliably conclude that the effect of the 1986 law was an increase in innovation, nor a jump in aggregate or sectorial productivity. What the reform certainly did, and Lo documents convincingly, was to increase the number of patents awarded to Taiwanese firms, especially in the U.S., which is altogether not surprising. Lo himself points out that the main channel through which the Taiwanese reform had a positive effect was by fostering foreign direct investment in Taiwan especially in those sectors in which patents are widely used.

This is an important point, which deserves a separate comment. In a world in which strong patent protection in some countries co-exists with weak protection in other, a country that increases patent protection should observe an increase in the inflow of foreign investment, especially in those sectors where patented technologies are used. Profit maximizing entrepreneurs always choose to operate in those legal environments where their rights are the strongest. In the U.S., for example, economists and people with common sense alike, have long argued that the policy of offering tax incentives and subsidies to companies that relocate in one state or another is not a good policy for the United States as a whole. Nobody denies that, if you provide a company with high enough subsidies and tax incentives, it will probably take them and relocate to your state, at least temporarily. The problem is that, after you do so, other states will respond by doing the same, or more. In the ensuing equilibrium, the total amount of investment is roughly the same as when no one was offering a tax incentive, but everyone is now paying a distorting tax. When capital moves freely across countries, the very same logic applies to the international determination of IP rights. In what economists call the Nash Equilibrium of this game, it is obvious that patent holders prefer to locate in countries with strong IP laws. This increases the stock of capital in the receiving country and reduces it everywhere else, especially in countries with low IP protection. Hence, absent international cooperation, the strong incentive of most countries to keep increasing patent protection, even in the absence of lobbying and bribing by intellectual monopolists. Which is why in the next chapter we invest abundant time discussing international harmonization of IP laws, and the TRIPS agreement.

As for the study by Kanwar and Evanson, they have data on 31 countries for the period 1981-1990. Using two 5 year averages they find support for the idea that higher protection leads to higher R&D as a fraction of GDP. Their measures of IP protection do not always seem to make sense, but this is not the proper place to

engage into a statistical diatribe. There are five levels of IP protection and R&D as a fraction of GDP ranges from a ten year average of .231% in Jordan to 2.822% in Sweden. They find that increasing IP by one level raises R&D as a fraction of GDP between 0.6% to 1.0%. As before, the most favorable interpretation of this result is that countries offering higher levels of IP protection also attract investments in those sectors in which R&D and patents are most relevant. A less favorable interpretation of this result, instead, points out that Kanwar and Evenson have forgotten to include a main determinant of the ratio of R&D to GDP: that is, market size as measured by GDP. The most elementary theory of innovation, either under competition or under monopoly, shows that the innovative effort is increasing in the size of the market, and that large and rich countries will invest a larger share of their GDP in R&D than small and poor countries. Putting Kanwar and Evanson's data together with GDP data from the 1990 CIA World Fact Book, we find that a 1% increase in the size of a country as measured by GDP increases the ratio of R&D to GDP by 0.34%.

It is interesting to looks at the residual error that is left over after we predict the ratio of (the logarithm of) R&D to GDP from (the logarithm of) GDP. Sorted by IP level we find

IP Level	*Average Residual*
0	-0.95
1	-0.46
2	0.20
3	0.20
4	0.10

What does this show? Once you control for market size, higher IP protection increases the R&D/GDP ratio at the very low levels, but becomes uncorrelated with the R&D/GDP ratio at any level of IP protection higher than 1 in the Kanwar and Evenson scale. This reinforces the idea that what we are seeing is primarily the effect of foreign investment. Among poor countries with low IP protection, increases bring in more foreign investment and raise R&D. In richer countries with high levels of IP, foreign investment is not an issue, and increases in IP have little or no effect on innovation.

The Scherer and Weisbrod study shows that it is perhaps not too wise for countries to rely on strengthening patent protection to bring in foreign investment. They show that when Italy introduced pharmaceutical patents in the 1970s, the Italian pharmaceutical

industry which had been thriving by making generic drugs, largely disappeared.

The Lerner study is especially notable, because he examined all significant changes in patent law in all countries over the last 150 years. His conclusion?

> *Consider, for instance, policy changes that strengthen patent protection. Once overall trends in patenting are adjusted for, the changes in patents by residents of the country undertaking the policy change are negative, both in Great Britain and in the country itself. Subject to the caveats noted in the conclusion this evidence suggests that these policy changes did not spur innovation.*

The remaining studies, like Lerner, find little or negative evidence that increased patent protection lead to increased innovation.

> *We find evidence that patents substitute for R&D effort at the firm level; they are associated with lower R&D intensity.* [Bessen and Hunt]

> *The results suggest that stronger patents may have facilitated entry by firms in niche product markets, while spawning "patent portfolio races" among capital-intensive firms.* [Hall and Ham]

> *... the 1980s strengthening of US patent rights spawned "patent portfolio races" among capital-intensive firms, but also facilitated entry by specialized design firms.* [Hall and Zeidonis]

> *It is too soon to draw any conclusion about what the effects will be of India's upcoming introduction of product patents for pharmaceuticals…Currently Indian firms are quite quick to bring imitations to markets…because of concern over global price regulations…innovative pharmaceuticals may actually become available to Indian consumers more slowly.* [Lanjouw]

> *… small firms prefer other mechanisms (e.g. secrecy) to protect their innovation or distrust patents, maybe because of the large costs involved in defending a patent. Another explanation of this result would be that small firms - on*

> *average - are more engaged in incremental innovation which does not fulfill the novelty requirement of patents. Moreover, large firms more probably apply for patent due to institutional requirements .... In addition, firms apply for patents because patents are used in cross-licencing agreements with other firms.* [Licht and Zoz]

> *Do patents matter? It may still be too early to tell in this case…None-the-less we do identify some distinct signs of stirring activity…it is hard to avoid the conclusion that the historical absence of IPRs played an important role in the retarding of development of new treatments for [malaria]. But, we cannot yet place too much confidence in this result. The upward trend seems in the data series to have disappeared in recent years.* [Lanjouw and Cockburn]

> *The main findings of this study are that in the group of sampled countries the implementation of patent laws by itself does not promptly stimulate domestic innovation.* [Qian]

> *However, econometric analysis using both Japanese and U.S. patent data on 307 Japanese firms finds no evidence of an increase in either R&D spending or innovative output that could plausibly be attributed to patent reform.*
> [Sakakibara and Branstetter]

Route 128 and Silicon Valley

We now take up the tale not of traditional intellectual monopoly such as patents and copyright, but that of restrictive "non-compete" labor contract clauses.

You have probably heard of Silicon Valley. Perhaps you have not heard of Route 128. Yet, Route 128 has been a high technology district since the 1940s, long before farmers were displaced from Santa Clara Valley, as Silicon Valley was then known, to make space for computer firms. In 1965 both Silicon Valley and Route 128 were centers of technology employment of equal importance, and with similar potentials and aspirations for further growth.

> *Route 128 began the race well ahead. In 1965, total technology employment in the Route 128 area was roughly*

> *triple that of Silicon Valley. By 1975, Silicon Valley employment had increased fivefold, but it had not quite doubled in Route 128, putting Silicon Valley about fifteen percent ahead in total technology employment. Between 1975 and 1990, the gap substantially widened. Over this period, Silicon Valley created three times the number of new technology-related jobs as Route 128. By 1990, Silicon Valley exported twice the amount of electronic products as Route 128, a comparison that excludes fields like software and multimedia, in which Silicon Valley's growth has been strongest. In 1995, Silicon Valley reported the highest gains in export sales of any metropolitan area in the United States, an increase of thirty-five percent over 1994; the Boston area, which includes Route 128, was not in the top five.*

What explains this radical difference in growth of the two areas? Certainly both had access to important universities, instrumental in the computer revolution – Harvard and MIT in the case of Route 128 and Stanford in the case of Silicon Valley. A careful analysis by Ronald J. Gilson shows that the only significant difference between the two areas lay in a small but significant difference between Massachusetts and California labor laws. According to Gilson

> *A postemployment covenant not to compete prevents knowledge spillover of an employer's proprietary knowledge not, as does trade secret law, by prohibiting its disclosure or use, but by blocking the mechanism by which the spillover occurs: employees leaving to take up employment with a competitor or to form a competing start-up. Such a covenant provides that, after the termination of employment for any reason, the employee will not compete with the employer in the employer's existing or contemplated businesses for a designated period of time--typically one to two years--in a specified geographical region that corresponds to the market in which the employer participates.*

In Massachusetts

> *Massachusetts law is generally representative of the approach taken toward postemployment covenants not to compete by the great majority of states. United States law in*

> *this area largely derives from English law that developed the basic pattern of blanket enforcement of covenants not to compete given by the seller in connection with the sale of a business, and the application of a rule of reason to covenants associated with employment. Covenants not to compete would be enforced against a departing employee if the covenant's duration and geographic coverage were no greater than necessary to protect an employer's legitimate business interest, and not otherwise contrary to the public interest. This formulation is commonplace in Massachusetts covenant cases, and dates to the late nineteenth century.*

By way of contrast, in California

> *California law governing covenants not to compete is both unusual and radically different from that of Massachusetts. California Business and Professions Code section 16600 provides that "every contract by which anyone is restrained from engaging in a lawful profession, trade, or business of any kind is to that extent void." The courts have interpreted section 16600 "as broadly as its language reads." ...Indeed, California courts' application of choice of law rules underscores the seriousness with which they view section 16600. Even if the employment agreement which contains a postemployment covenant not to compete explicitly designates the law of another state, under which the covenant would be enforceable, as controlling, and even if that state has contacts with the contract, California courts nonetheless will apply section 16600 on behalf of California residents to invalidate the covenant.*

Contrary to many business pundits, the reader of this book will perhaps not be surprised at the beneficial consequences of the Silicon Valley competitive environment. While Sexanian, in her otherwise informative book, remarks

> *The paradox of Silicon Valley was that competition demanded continuous innovation, which in turn required cooperation among firms.*

we know that there are good economic reasons why it must be so: competition is the mechanism that breeds innovation, and sustained competitive innovation, paradoxical as that may sound to those that

do not understand it, often is best implemented via cooperation among competing firms.

While Route 128 companies spent resources to keep knowledge secret – inhibiting and preventing the growth of the high tech industry – in California this was not possible. And so, Silicon Valley – freed of the millstone of monopolization – grew by leaps and bounds as employees left to start new firms, rejoined old firms and generally spread socially useful knowledge far and wide.

Data Bases

The case of databases is still an experiment in the making. Unusually enough, the U.S. is, at least for now, on the right side of the divide. Databases are "compilations of matter," which is broad and generic enough to include your personal list of people to whom you send Valentine cards, the Human Genoma, the local yellow pages, and the mailing list of those damned spammers. Databases, it seems obvious, have become increasingly important for private individuals, businesses, academic researchers, industrial R&D and, unfortunately, also for national security.

The experiment-in-the-making and the intense debate accompanying it, both began in 1996. On March 11, the European Union issued a Directive requiring member states to provide statutory protection of data-bases on the basis of copyright, even if the data base in question contained material that was not itself under copyright. The E.U. also tried to force nonmember states to accept its Directive. It did this by deciding that EU protection would be extended to their citizens only if the nonmember states provided similar protection. By 2001 all EU countries had fully implemented the EU Directive.

How about the United States? Stephen Maurer and Suzan Scotchmer summarize the situation here in the following terms

> *Except for opposition from the scientific and engineering communities, the United States probably would have signed a database protection treaty in 1997 and adopted corresponding domestic legislation in 1998. A revised bill known as H.R. 354, the Collections of Information Antipiracy Act, is currently pending in Congress.*

As far as we know, the revised bill has not yet been approved, and the discussion is still open. This means that in the U.S. until now, at least, databases are not the objects of intellectual monopoly.

Databases, if you think of it, come extremely close to the idealized "pure information" that intellectual monopoly apologists talk about and that, according to dominant economic theory, is expensive to produce but absolutely cheap to copy. Maurer and Scotchemer are aware of this, and also of the puzzling fact that very expensive data bases keep being produced and traded without IP protection

> *The usual argument for statutory protection sounds simple and compelling. Databases are expensive to make but cheap to copy. For this reason, private and commercial database owners cannot compete with copiers in an open market. If databases cannot earn a fair return under existing law, no rational business would invest in them until Congress changed the rules. Instead, databases flourish*

Further

> *Finally, many of the most popular and powerful methods depend on the marketplace. If consumers want frequent updates, a would-be copier has little to gain by offering last month's database at a bargain price. Similarly, consumers may think that a particular database is more valuable if it comes with copyrighted search software. In either case, copiers can only compete by making substantial investments of their own. The resulting protection is particularly effective in the sciences, where up-to-date, searchable data sets are at a premium.*

Why after pointing out all this and convincingly documenting the dramatically negative impact that introducing IP coverage of data bases would have on both academic research and business activity in the U.S., Maurer and Scotchmer decide to open up the door to some amount of intellectual monopoly by adding

> *Congress could strengthen these methods still further by protecting each update or correction for 1 to 2 years. Such legislation would be far less restrictive than H.R. 354's proposed 15-year period.*

beats us, but that is a different debate, which we leave for later.

In the meanwhile the experiment continues along another dimension. Which one do you think is higher: The rate of creation of

databases in the E.U. – where they are protected by IP – or in the U.S. – where they are not? Well, you guessed it right this time: in the U.S. In fact, it is not even a race, the U.S. wins hands down, as Block points out. After documenting in details the excellent state of the data base industry in the U.S., its amazing growth rate and productivity as well as the fact that the adoption of the Directive does not seem to have produced any sustained increase in the E.U.'s production of databases, he adds

> *For the entire period measured, U.S. online database production outpaced all of Europe by a factor of nearly 2.5:1 ... American dominance of database production cannot be explained by incentives given to creators because American protection of database rights is much weaker than the Directive.*

To which we only add that, most probably, American dominance of the industry *can* be explained by economic incentives to creators as measured by the actual profits accruing to them and by the competitive environment in which they operate, and that, almost certainly, neither of them is increased much by the EU Directive. Our conjecture is that, within a few years, some smart applied economist will write an interesting Ph.D. dissertation showing just this.

Simultaneous Discovery

Insofar as inventors have unique ideas it may make sense to reward them with monopolies to make sure we get advantage of their unusual talents. For example, if, in the absence of James Watt, the steam condenser would not have been invented until long after his patent expired, there is some justification for having awarded him a monopoly. Of course if others were going to discover it in a few years anyway, then it scarcely made sense to give him a long-term monopoly. As it happens simultaneous discoveries tend to be the rule rather than the exception, and they almost always lead to some ugly stories. Those that follow may not be the most remarkable, they are just those we happen to have learned about. Many more, most certainly, are sitting out there, just waiting to be told. Because, you see, simultaneous discovery is not the exception, it is the rule and even that greatest of all the modern innovators, our beloved James Watt, stumbled into it, as Carnegie reports

> *His first discovery was that of latent heat. When communicating this to Professor Black he found that his friend had anticipated him, and had been teaching it in lectures to his students for some years past.*

Since then, things have changed little along this dimension – if anything, simultaneous discovery has become more and more the rule, not the exception, nowadays.

Radio Waves

The radio, according to popular history, was invented by the great inventor Guglielmo Marconi. Indeed, some authors, such as Hong, go to great pains to argue the originality of Marconi relative to his contemporaries and the various other people that, between 1896 and 1898 claimed to have reached, or being poised to reach, wireless transmission of radio signals at a substantial distance.

Abundant evidence, including the very same evidence reported by Hong himself in his passionate defense of Marconi, suggests otherwise. There are many competitors, which is to say: many people who have claimed to have invented the radio in a form more or less similar, but functionally equivalent, to Marconi. They range from the most official ones, the British physicist Oliver Lodge in the United Kingdom, and the forgotten genius Nikoli Telsa in the United States, to the least loved one, the Russian Aleksander Popov who, it is now clearly documented, described his findings in a paper published in 1895 and demonstrated the functioning of his apparatus in front of the St Petersburg Physical Society in March 1896, to the most relevant but least visible one, Henry B. Jackson, an engineer working for the Royal Navy.

The latter, who never complained about Marconi's patent and was in fact a friend of Marconi's, writes in an official report of May 2, 1897:

> *Comparing my experiments with those of Mr. Marconi, I would observe that before I heard of his results, I had succeeded with the instruments at my disposal in transmitting Morse signals with my apparatus about 100 yards, which I gradually increased to one-third of a mile, but could not improve upon till I obtained a more powerful induction coil last month, with which I have obtained my present results, using Marconi's system wires insulated in the air attached to transmitter and receiver ... With this*

> *exception, the details of my apparatus, which so closely resembles his, have been worked out quite*

Marconi was using established science at the time. "Long-run detection of Hertz waves" was a widely studied topic. Frontier science, certainly, but there is no real scientific discovery in his black box. Similar experiments were carried out by Ernest Rutherford at Cambrige Cavendish Laboratory as early as 1895-96. In describing Marconi's equipment, which is extremely similar to that of Rutherford and Jackson, even in the size of many parts, Hong concludes that "There was an element of 'non-obviousness' in Marconi's solutions: his grounding of one pole of the transmitter and one pole of the receiver." So Marconi's contribution to solving the puzzle was the grounding of antenna and transmitter.

Trotter, Threlfall, and Crookes were all anticipators of Marconi's findings. Lodge's lecture to the August 1894 meeting of the British Association for the Advancement of Sciences at Oxford on using Hertzian waves to transmitting signals also anticipated Marconi. Marconi started work on this in 1895. As it is clear from his first filing for patent on June 2, 1896, he does not really understand Hertzian waves yet

> *In his patent for wireless telegraphy, Marconi claimed almost everything about the use of the coherer (**which had been invented by Branly and improved by FitzGerald and Lodge** [emphasis ours]) in wireless telegraphy. In May 1897, Lodge had applied a patent for a system of wireless telegraphy of his own … but he had had to withdraw his claims on the coherer and the tapper because they had been so throughly covered by Marconi.*

Marconi's final specification for the patent in 1897 is a "different kind of document entirely" from the initial one, thanks to the contribution of J. Fletcher Moulton and others, and it successfully manages to patent pretty much "everything" that goes into a radio, a radio transmitter, and a radio receiver. Not bad for a guy whose contribution was to ground the antenna!

Because Marconi came from an aristocratic family and had very good connections in London, he was able to patent first and to get away with patenting under his name lots of components that had been invented by other. Also because of his family connections in the City's financial circles, the Marconi Wireless Telegraph Company, Ltd. was readily established and handsomely financed in

1897; it began thriving right away – its stock soaring from $3 to $22 in less than a year. The American Marconi Co. was formed in 1899, attracting investments from local big guns of the size of Thomas Edison and Andrew Carnegie. Then, on December 12, 1901, Marconi for the first time transmitted and received signals across the Atlantic Ocean. By 1903, the Marconi Company was carrying regular transatlantic news transmissions. End of story. Well, not quite.

Marconi may have been a glamorous and successful aristocrat but he was an Italian aristocrat, and his patent was so broad that it left everybody else in England out in the cold. Furthermore, he was clearly appropriating rights over instruments that he had not invented and that were already widely used. All of this generated a strong reaction. While this reaction did not affect Marconi's financial fortunes, nor did it allow those left out in the cold into the competition, it did at least leave enough documentation and bad feelings that we can now learn something from this experience.

To complete our learning, let us summarize what happened on the other side of the Atlantic. Nikola Tesla, the forgotten genius who has only recently come to renewed attention, filed for various radio patents in 1897. They were granted in 1900. This lead to a repeated rejection of Marconi's application for a radio patent in the U.S., on the ground that Tesla's invention preceeded his. We learn that the Patent Office, in 1903, pointed out the following while rejecting yet another Marconi's application:

> *Many of the claims are not patentable over Tesla patent numbers 645,576 and 649,621, of record, the amendment to overcome said references as well as Marconi's pretended ignorance of the nature of a "Tesla oscillator" being little short of absurd... the term "Tesla oscillator" has become a household word on both continents*

So why did no N. Tesla Broadcasting Co. hold a complete monopoly over radio communications in the U.S. until late in the 1920s? Why did Nikola Tesla die poor while Marconi enriched himself, on his way to a Nobel prize? Because, you see, now like then, the game of patenting and intellectual monopoly is not all that democratic and open to the little guys as Ms. Kahn's recent book would like us to believe. Then, like now, when the big guys want a position of intellectual monopoly they end up getting it, original patent or not. So it is the case that Marconi, supported by the likes

of Edison and Carnegie, kept hammering the U.S. Patent Office until, in 1904, they reversed course and gave Marconi a patent for the invention of radio. We read that

> *The reasons for this have never been fully explained, but the powerful financial backing for Marconi in the United States suggests one possible explanation.*

We will spare you the sad story of Nikolas Tesla's hapless fight against Marconi, you can figure that out by yourself. In fact: we are sparing you also the stories of the many other fights poor Tesla lost against some of the great "inventors" and "entrepreneurial geniuses" of the time, Edison foremost. The bottom line is that Tesla never got to see the rewards of his genius.

We beg you to note that the issue here is not whether Tesla or Marconi was the rightful monopolist of radio. Rather, the moral of this story is that simultaneous inventions are frequent, they are the rule and not the exception. The moral is that the patent system prevents simultaneous inventions from being recognized and utilized by society. And the moral, finally, is that the patent system destroys productive capacity, generates useless and damaging monopoly and, last but not least, humiliates and destroys decent and humble geniuses like Aleksander Popov and Nikolas Tesla.

The story of injustice to Nikolas Tesla has a tragicomic ending: in 1943 the U.S. Supreme Court upheld Tesla's radio patent reversing the earlier decision of the U.S. Patent Office. Of course, Tesla was dead by this time – and indeed that is why he was awarded the patent. The United States Government had been sued by the Marconi Company for use of its patents during the First World War. By awarding the patent to Tesla, they eliminated the claim by Marconi – and faced no similar claim from Tesla, who, being dead, was unable to sue.

Locking and Unlocking the Skies

As the radio was invented by the great inventor Marconi, so was the airplane invented by the great Wright Brothers.

Again, however, the popular history turns out to be rather misleading. At the beginning of the nineteen century, Sir George Cayley had already written down and detailed the necessary specification for the design of a successful airplane. The main difficulties: the lack of a lightweight power source, and the control of flight, especially changing direction and altitude. Otto Lilienthal (1848-1896) had made many successful flights on a hang gliders

built by himself; thereby learning a number of crucial things about the management of flying. He killed himself in the tentative beginning of applying power to the hang glider. It is to Lilienthal, in fact, that the idea of "wing warping" is to be attributed. When the Wright brothers applied for the first patent in 1902, it was for the system of flight control obtained by the combined used of warping and the rudder – that is, a very marginal improvement over existing technology.

It should be noticed as well that modern airplanes are not controlled by "wing warping" but rather by movable control surfaces – elevators and ailerons. These were invented not by the Wright brothers, but by Glenn Curtis – a fact that did not prevent the Wright brothers from suing Glenn Curtis based on their patent over "wing warping."

Indeed, the story of the Wright brothers is not so terribly different than those of James Watt and Marconi: like Watt and Marconi they made a marginal improvement in an existing technology, and then used the patent system in an effort to monopolize an entire industry. The Wright brothers were merely less successful – perhaps lacking a politically connected partner such as Boulton or Marconi's aristocratic connections – and were also unable to prevent innovation from taking place in France where most serious airplane development took place beginning in around 1907. Because we have probably tired you with the details of the Marconi's story, we will spare you the Wrights': the only difference being that the Wright's brother were slightly less successful at the monopoly game.

But, at least, the Wright brothers were the undisputed first, were they not? Well, maybe. When you are done reading this book – or this paragraph, if you are impatient – go to the omnipresent Google, and enter "Mad Pearse, also known as Bamboo Dick" and then hit the "I'm Feeling Lucky" button.

Tele-things

Similar stories could and should be told, in sequence, for the many "tele-things" that, since the middle of the nineteenth century have revolutionized our way of living: the telegraph, the telephone, and the television. Nothing really new would be added, though, to the lessons learned so far, and some of those stories, in particular the one about the telephone and the growth of the Bell monopoly, do not make for a simple and entertaining summary.

In a nutshell, the telegraph, the telephone and the television are clear cases of simultaneous invention and cumulative discovery

by a number of more or less disconnected inventors. In all three cases one of the inventors participating in the cumulative effort – generally the one with the smallest contribution but the best connections and the most cunning instinct for the monopoly game – got the patent, the glory, and the monopoly profits. Thanks to the patent system, the other innovators were left out in the cold, without economic reward, without the right to make copies of their own invention, without the right to compete in the market, and without any fame. Of course, it may be that the 2002 declaration by the U.S. Congress that Antonio Meucci invented the telephone was a suitable form of compensation for his invention. Given that, at the time of the ruling, Meucci had been dead for many decades we very much doubt that he would have felt that this was the case.

The Moral

The moral of these, and dozens of other stories is simple. Most great inventions are cumulative and simultaneous; most great inventions could have been introduced simultaneously, or almost so, by many different inventors and companies, competing among them to improve the product and to sell it to consumers at a price as low as possible; most great inventions could have spread more rapidly and improved more quickly if the social productive capacity that simultaneous inventions generate had been usable; all of us, but a dozen undeserving monopolists, would have been better off. None of this has happened, and none of this is happening, because the system of intellectual monopoly blocks it. Intellectual monopoly has historically given and still gives all the rewards to a lucky and often undeserving person who manages, in one way or other to get the patent and grab the monopoly power. As the stories we have told show, this is absolutely not necessary for great inventions to take place. It is damaging for society, as valuable productive capacity is literally destroyed and thrown away. Finally, if you forgive us, it is also awfully unfair.

Notes

The advantages and disadvantages of intellectual monopoly when innovations build on previous innovations is discussed in Scotchmer [1991] and Boldrin and Levine [1999], who construct examples in which competition achieves the first best, while intellectual monopoly fails to innovate at all. More elaborate modeling and a more exhaustive analysis of the very negative role intellectual monopoly plays when complexity of innovations increases can be found in Boldrin and Levine [2005a, 2005c].

Writing about the use of patents to lure investments away from other countries tempted us to engage in a, possibly not irrelevant, digression on the role that patents played in Europe, roughly, between 1400 and 1800. We resisted the temptation, but here are some hints for further reading. The original purpose of patents was to attract specific groups of artisans and highly skilled professionals that were, for a reason or another, lacking in the country promising the patent. Monopoly was the carrot offered by most Italian and Northern-Euroepan cities to inventors that accepted to immigrate. In England, during the seventeenth, eighteenth and most of the nineteenth centuries a royal patent privilege was awarded to those citizens who would travel abroad and be the first to bring back new goods and technologies. United States patent laws were less inclined to provide incentives to pirate foreign innovators, but it still discriminated heavily against foreign citizens and innovations until the 1861 reform; pirating of foreign inventions, especially British, was thriving. Notice the interesting fact: all these practices just amounted to imitation, or piracy in modern jargon, rewarded with local monopoly! This is something worth keeping in mind in the light of current sermons against Indian, Chinese, Mexican and Brazilian people "pirating our inventions." Our reading of historical records is that all this "reciprocal stealing" had no effect on the total amount of inventions. If you care reading more, a few good books from where to start are Kahn [2005, Chapter 2], Landes [1969] and Landes [1998].

It should be apparent that everything we know about the impact of copyright on classical music we have learned from Scherer [2004], and references thereof.

The research work of Kahn, Lamoreux and Sokoloff we mention is covered in a variety of articles and books, including the book by Kahn [2005] already quoted, which contains a very broad bibliography. On the growth of intermediaries and their role see Lamoreaux and Sokoloff [2002].

Petra Moser's dissertation, which won the 2003 Gerschenkron Prize awarded by the Economic History Association to the best dissertation in the field, is a mine of valuable information on the role of patents in determining innovative activity during the 19th and early 20th century. The main findings are summarized in Moser [2003], from which we quote.

All the empirical studies listed in the long table can be found in the references at the end. The data about patents come from the 2003 Annual Report of the USPTO, which can be found on line at //www.uspto.gov/web/offices/com/annual, additional basic data is from www.cms.hhs.gov.

For the Route 128 versus Sylicon Valley story our main source is Gilson [1999], from which we quote. For more details, though, see also the books by Saxenian [1994], and Kenney and von Burg [2000]. The quote from Saxenian is at page 46.

We have learned about databases from Block [2000], David [2001], Maurer [1999], Maurer et al. [2000] and Maurer and Scotchmer [2001], from which we also quote.

Carnegie's quotation is from Chapter 3 of his 1905 book eulogizing James Watt.

To learn about Marconi and his contested invention we started with Hong [2001], if anything because he tries harder than most to show that there was no simultaneous invention. The quote is from Jackson [1897] and is quoted on p. 17 of Hong [2001]; it is also referenced in Burns [2004]. On the web one can find lots of well structured sites; we have made use of the Marconi's page on the Wikipedia - where we learned about Popov, in particular: that he was not a fraud, as one of us had been taught in junior high, and that he "died in 1905 and his claim was not pressed by the Russian government until 40 years later." The no longer controversial facts about Tesla are reported in various places, including Johnston [1982] and Lomas [1999], and then continuing on with www.pbs.org/tesla/ll/ll_whoradio.html and the many other sites that in recent years have rediscovered Tesla, the genius that the patent system ignored.

Brock [1981] is a detailed and certainly unbiased (better said: biased, but on the other side) history of both the telegraph and the telephone industries, that make up the telecommunication industry in the title. As the author seems to believe that monopoly pricing, cartels, stealing of inventions, political favors, and all the legal tricks that come with this, are business tools that any good entrepreneur should master and possibly adopt, he does not spare us the gory details. The book was written before the US Congress ruled

that Bell stole the telephone invention from Antonio Meucci, hence Brock reports only that Bell's patent was filed two hours earlier of an equivalent one by Elisha Gray, describing the same "invention." This, obviously, makes the whole thing even more entertaining in retrospect, as it proves once again that big simultaneous inventions are more the rule than the exception, and that big simultaneous stealing is also part of the feasible set (on the latter, see www.esanet.it/chez_basilio/schiavo_xv.htm.) Historical details about Antonio Meucci can now be found everywhere; for the U.S. Congress resolution, passed on June 16, 2002, see www.guardian.co.uk/international/story/0,3604,738675,00.html.

As for the television, another "business is business" description can be found in the paper by Maclaurin [1950]. Maclaurin somehow recognizes that television was a classical case of simultaneous invention, which was solved partly by forcibly pushing out of the playing field some of the inventors, and partly by building a monopolistic cartels among the survivors. Like every good follower of Schumpeter, though, Maclaurin concludes that the waste of productive capacity this involved, and the monopolistic pricing it generated, were good things. What's good for RCA is good for America, it seems. For different renditions of Philo T. Farnsworth's contribution to the invention of television, see the sharp booklet by Roberts [2003] or the longer and more romanticized biography by Schwartz [2003].