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London School of Economics, Theory Workshop; Loyola University, Chicago; Northwestern, Theory Workshop; NYU, Economics Department; Oxford, Economics Department; Pompeu Fabra, Theory Workshop; Purdue University, Economics Department; Rochester University, Theory Seminar; Rochester University, Wegmans conference; SED Conference, Paris; Stanford, macroeconomics workshop; SUNY Buffalo, Economics Department; Toulouse Theory Workshop; UCLA, Economics Department; UC Berkeley, Macroeconomics Workshop; University of Alabama, Theory Workshop; University of Chicago, Theory Workshop; University of Kansas, Theory Workshop; Universidad Autonoma, Madrid, Economics Department; Venice International University, Economics Department; Wisconsin Madison, Economics Department; World Bank - Pompeu Fabra conference; Wuhan University, Economics Department; and Yale, Cowles Commission.

Chapter 1: Introduction

In late 1764, while repairing a small Newcomen steam engine, the idea of allowing steam to expand and condense in separate containers sprang into the mind of James Watt. He spent the next few months in unceasing labor building a model of the new engine. In 1768, after a series of improvements and substantial borrowing, he applied for a patent on the idea, requiring him to travel to London in August. He spent the next six months working hard to obtain his patent. It was finally awarded in January of the following year. Nothing much happened by way of production until 1775. Then, with a major effort supported by his business partner, the rich industrialist Matthew Boulton, Watt secured an Act of Parliament extending his patent until the year 1800. The great statesman Edmund Burke spoke eloquently in Parliament in the name of economic freedom and against the creation of unnecessary monopoly – but to no avail.[1] The connections of Watt's partner Boulton were too solid to be defeated by simple principle.

Once Watt's patents were secured and production started, a substantial portion of his energy was devoted to fending off rival inventors. In 1782, Watt secured an additional patent, made "necessary in consequence of ... having been so unfairly anticipated, by [Matthew] Wasborough in the crank motion."[2] More dramatically, in the 1790s, when the superior Hornblower engine was put into production, Boulton and Watt went after him with the full force of the legal system.[3]

During the period of Watt's patents the U.K. added about 750 horsepower of steam engines per year. In the thirty years following Watt's patents, additional horsepower was added at a rate of more than 4,000 per year. Moreover, the fuel efficiency of steam engines changed little during the period of Watt's patent; while between 1810 and 1835 it is estimated to have increased by a factor of five.[4]

After the expiration of Watt's patents, not only was there an explosion in the production and efficiency of engines, but steam power came into its own as the driving force of the industrial revolution. Over a thirty year period steam engines were modified and improved as crucial innovations such as the steam train, the steamboat and the steam jenny came into wide usage. The key innovation was the high-pressure steam engine – development of which had been blocked by Watt's strategic use of his patent.

Many new improvements to the steam engine, such as those of William Bull, Richard Trevithick, and Arthur Woolf, became available by 1804: although developed earlier these innovations were kept idle until the Boulton and Watt patent expired. None of these innovators wished to incur the same fate as Jonathan Hornblower.[5]

Ironically, not only did Watt use the patent system as a legal cudgel with which to smash competition, but his own efforts at developing a superior steam engine were hindered by the very same patent system he used to keep competitors at bay. An important limitation of the original Newcomen engine was its inability to deliver a steady rotary motion. The most convenient solution, involving the combined use of the crank and a flywheel, relied on a method patented by James Pickard, which prevented Watt from using it. Watt also made various attempts at efficiently transforming reciprocating into rotary motion, reaching, apparently, the same solution as Pickard. But the existence of a patent forced him to contrive an alternative less efficient mechanical device, the "sun and planet" gear. It was only in 1794, after the expiration of Pickard's patent that Boulton and Watt adopted the economically and technically superior crank.[6]

The impact of the expiration of his patents on Watt's empire may come as a surprise. As might be expected, when the patents expired "many establishments for making steam-engines of Mr. Watt's principle were then commenced." However, Watt's competitors "principally aimed at...cheapness rather than excellence." As a result, we find that far from being driven out of business "Boulton and Watt for many years afterwards kept up their price and had increased orders."[7]

In fact, it is only after their patents expired that Boulton and Watt really started to manufacture steam engines. Before then their activity consisted primarily of extracting hefty monopolistic royalties through licensing. Independent contractors produced most of the parts, and Boulton and Watt merely oversaw the assembly of the components by the purchasers.

In most histories, James Watt is a heroic inventor, responsible for the beginning of the industrial revolution. The facts suggest an alternative interpretation. Watt is one of many clever inventors working to improve steam power in the second half of the eighteenth century. After getting one step ahead of the pack, he remained ahead not by superior innovation, but by superior exploitation of the legal system. The fact that his business partner

patents and copyrights would be like, it would not be a world devoid of great new music and beneficial new drugs.

You will gather by now that we are skeptical of monopoly – as are economists in general. Our second topic will be an examination of the many social costs created by copyrights and patents. Adam Smith – a friend and teacher of James Watt – was one of the first economists to explain how monopolies make less available at a higher price. In some cases, such as the production of music, this may not be a great social evil; in other cases such as the availability of AIDS drugs, it may be a very great evil indeed. However, as we shall see, low availability and high price is only one of the many costs of monopoly. The example of James Watt is a case in point: by making use of the legal system, he inhibited competition and prevented his competitors from introducing useful new advances. We shall also see that because there are no countervailing market forces, government-enforced monopolies such as intellectual monopoly are particularly problematic.

While monopoly may be evil, and while innovation may thrive in the absence of traditional legal protections such as patents and copyrights, it may be that patents and copyrights serve to increase innovation. The presumption in the U.S. Constitution is that they do, and that the benefits of more entertainment and more innovation outweigh the costs of these monopolies. Certainly the monopolies created by patents and copyright may be troublesome – but if that is the cost of having blockbuster movies, automobiles and flu vaccine, most of us are prepared to put up with it. That is the position traditionally taken by economists, most of whom support patents and copyright, at least in principle. Some of them take the view that intellectual monopoly is an unavoidable evil if we are to have any innovation at all; other simply argue that at least some modest amount of intellectual monopoly is desirable to provide adequate incentive for innovation and creation. Our third topic will be an examination of the theoretical arguments supporting intellectual monopoly, as well as counter-arguments about why intellectual monopoly may hurt rather than foster creative activity.

It is crucial to recognize that intellectual monopoly is a double-edged sword. The rewards to innovative effort are certainly greater if success is awarded a government monopoly. But the existence of monopolies also increases the cost of creation. In one extreme case, a movie that cost $218 to make had to pay $400,000 for the music rights.[19] As we will argue at length, theoretical

arguments alone cannot tell us if intellectual monopoly increases or decreases creative activity.

In the final analysis, the only justification for intellectual property is that it increases – *de facto* and substantially – innovation and creation. What have the last 219 years taught us? Our final topic is an examination of the evidence about intellectual monopoly and innovation. Is it a fact that intellectual monopoly leads to more creativity and innovation? Our examination of the data shows no evidence that it does. Nor are we the first economists to reach this conclusion. After reviewing an earlier set of facts in 1958, the distinguished economist Fritz Machlup wrote

> *"it would be irresponsible, on the basis of our present knowledge of its economic consequences, to recommend instituting [a patent system]."*[20]

Since there is no evidence that intellectual monopoly achieves the desired purpose of increasing innovation and creation, it has no benefits. So there is no need for society to balance the benefits against the costs. This leads us to our final conclusion: intellectual property is an unnecessary evil.

Comments

We are grateful to George Selgin and John Turner, of the University of Georgia Terry College of Business, for pointing out a number of factual mistakes and imprecisions in our rendition of the James Watt story, as it had appeared in earlier versions of this chapter and in our 2003 Lawrence R. Klein Lecture, published in Boldrin and Levine [2004]. In a recent article, Selgin and Turner [2006], also take issue with our interpretation of the facts and add a few additional ones that, in their view, contradict our vision of James Watt as a primary example of an intellectual monopolist. It seems clear, even from the references quoted by Selgin and Turner, that many students of the Industrial Revolution share our view – more properly: we shared theirs.

Selgin and Turner's argument and facts do not, however, address the issues we raise about Boulton and Watt. Take their discussion of the hypothetical "Watt sans patent." Obviously Boulton and Watt fought hard for their patents, and obviously they claimed innovation would have been impossible without them. Our point is another: could they have made enough money to compensate their opportunity cost without the patent? All the evidence, including that reported by Selgin and Turner, suggests this is the case. In fact they make our case quite convincingly: quoting F.M. Scherer they assert that seventeen years before the second patent expired they, Boulton and Watt, were already breaking even. In economics, "breaking even" means that your opportunity costs have been paid, and your capital has received the risk-adjusted, expected return, and Scherer is a distinguished economist. Whatever profits Boulton and Watt made after that, were all extra rents due to monopoly power and, economically, not needed to pay their opportunity costs. So, we all agree that, at least for the final 17 years, the patent was not serving a useful economic purpose, hence it was damaging because it created monopoly distortions.

Notes

[1] Lord [1923] p. 5-3.htm.
[2] Carnegie [1905] p. 157.

[3] Much of the story of James Watt can be found in Carnegie [1905], Lord [1923], and Marsden [2004]. Information on the role

of Boulton in Watt's enterprise is drawn from Mantoux [1905]. A lively description of the real Watt, as well of his legal wars against Hornblower – and many other – and of how he subsequently used his status to alter the public memory of the facts, can be found in Marsden [2004]. That Pickard's patent was unjust is also the view of Selgin and Turner (2006), who, like Watt, do not seem to provide any evidence of why it was so.

As both the Lord and Carnegie works are out of copyright, both are available online at the very good Rochester site on the history of steam power www.history.rochester.edu/steam. Later drafts of this chapter benefited enormously from the arrival of Google Book Search, which allowed us to check so many original historical sources about James Watt and the steam engine we would have never thought possible.

[4] Lord [1923] gives figures on the number of steam engines produced by Boulton and Watt between 1775 and 1800, while the *The Cambridge Economic History of Europe* [1965] provides data on the spread of total horsepower between 1800 and 1815 and the spread of steam power more broadly. However, Kanefsky [1979] has largely discredited the Lord numbers, which is why we use figures on machines and horsepower from Kanefsky and Robey [1980].

Our horsepower calculations are based on 510 steam engines generating about 5,000 horsepower in the U.K. in 1760. During the subsequent forty years we estimate that about 1,740 engines generating about 30,000 horsepower were added. This gives our estimate that the total increased at a rate of roughly 750 horsepower each year. For 1815 we estimate about 100,000 horsepower – that is, the average of the figures Kanefsky and Robey [1980] give for 1800 and 1830. This together with the 35,000 horsepower we estimate for 1800 gives our estimate that the total increased at a rate of roughly 4,000 horsepower each year after 1800.

Data on the fuel efficiency, the "duty," of steam engines is from Nuvolari [2004b].

[5] Kanefsky and Robey [1980] together with Smith [1977-78] provide a careful historical account of the detrimental impact of the Newcomen's, first, and of Watt's patents, later, on the rate of adoption of steam technology. Apart from the books just quoted, information about the Hornblower's engine and its relation to

Watt's are widely available through easily accessible web sites, such as Encyclopedia Britannica, Wikipedia, and so on. Some details of Hornblower's invention may be of interest. It was patented in 1781 and consisted of a steam engine with two cylinders, significantly more efficient than the Boulton and Watt design. Boulton and Watt challenged his invention, claiming infringement of their patent because Hornblower engine used a separate condenser, and won. With the 1799 judicial decision against him, Hornblower had to pay Boulton and Watt a substantial amount of money for past royalties, while losing all opportunities to further develop the compound engine. His compound steam engine principle was not revived until 1804 by Arthur Woolf. It became one of the main ingredients in the efficiency explosion that followed the expiration of Boulton and Watt's patent.

Watt's low-pressure engines were a dead end for further development; history shows that high-pressure, non-condensing engines were the way forward. Boulton and Watt's patent, covering all kinds of steam engines prevented anyone from working seriously on the high-pressure version until 1800. This included William Murdoch, an employee of Boulton and Watt, who had developed a version of the high-pressure engine in the early 1780s. He named it the "steam carriage" and was legally barred from developing it by Boulton and Watt's successful addition of the high-pressure engine to their patent, although Boulton and Watt never spent a cent to develop it. For the details of this story the reader should check the on line site Cotton Times at http://www.cottontimes.co.uk/ or Carnegie [1905, pp. 140-141]. The "William Murdoch" entry in Wikipedia provides a good summary. More generally various researchers directly connect Murdoch to Trevithick, who is now considered the official "inventor" (in 1802) of the high-pressure engine. Quite plainly, the evidence suggests that Boulton and Watt's patent retarded the high-pressure steam engine, and hence economic development, of about 16 years.

[6] The story about Pickard's patent blocking adoption by Watt is told in von Tunzelmann [1978].

[7] Thompson [1847] p. 110 and quoted also in Lord [1923].

8 Scherer [1984] pp. 24-25.

[9] U.S. District Court for Eastern District of Virginia Plaintiff NTP, Inc. v. Defendant Research In Motion Ltd. Civil Action Number 3:01CV767-JRS.

[10] U.S. Patent 6219694.

[11] United States Court of Appeals for the 9th Circuit Court, In Re: Napster.

[12] Stephen Manes [2004] .

[13] Lessig [2004].

[14] Robert Barro and Xavier Sala-i-Martin [1999] p. 290.

[15] *The Economist*, June 23rd 2001, page 42, with italics added.

[16] Information on U.S. Patent Law can be found at the U.S. Patent Office at www.uspto.gov/main/patents.htm. In addition to utility and design patents, there is also a third class of patent, the plant patent. Like a utility patent, a plant patent lasts 20 years.

[17] The Sony Bono Copyright Extension Act can be found online at library.thinkquest.org/J001570/sonnybonolaw.html, while the Berne Convention on Copyright can be found at www.law.cornell.edu/treaties/berne/. A useful discussion of fair use, including parodies, is Gall [2000].

[18] U.S. Constitution Article 1, Section 8. The U.S. Constitution, not being copyrighted, is online at various places, such as http://www.law.cornell.edu/constitution.

[19] The $218 movie was *Tarnation* and the information from BBC News, is at http://news.bbc.co.uk/2/hi/entertainment/3720455.stm.

[20] Machlup [1958], p. 80. He nevertheless concluded that we should keep the patent system. We discuss his position further in our conclusion.

Chapter 2: Creation Under Competition

The basic conclusion of this book is that intellectual monopoly – patents, copyrights and restrictive licensing agreements – are unnecessary. Always beware of theorists bearing radical ideas – most ideas are bad, and most theories are wrong. This book may be yet another entry in that long list of confused and confusing dreamers.

Therefore, we must first and foremost convince you that our ideas are firmly grounded in facts and practice – most innovations have taken place without the benefit of intellectual monopoly. Indeed, the system of intellectual monopoly as it exists today is of recent vintage – some parts of the current system are only a few years old and their damaging effects are already visible and dramatic.

No Gardens of Utopia, then, but the fertile fields of Practical Experience, as illustrated by thriving markets without intellectual monopoly, that is what this and the next chapter are about.

Software

In spite of being all around us, facts are often invisible because we look at them with wrong shaded glasses. Look closely at the computer on your desk. You see a mouse, a keyboard, and, on your screen, a bunch of different overlapping windows with word processors, spreadsheets, instant messengers and a web browser through which you can access a vast array of information on a large diversity of subjects. At the end of the Second World War – sixty years ago – digital computers did not exist – nor of course did the software that makes them work. In few industries has there been such extensive innovation as in the software industry – and few technologies have changed our way of life as much. Will it surprise you to learn that virtually none of the innovations in this industry took place with the protection of intellectual monopoly? Our tour of the hidden world where innovation flourishes under competition starts here, in the software industry.

We read about Amazon suing Barnes and Noble for patent infringement – and being sued by IBM for the same – and we do not know whether to laugh or to cry. We find Microsoft hinting that they will sue us for patent infringement if we use GNU/Linux instead of Windows.[1] It seems as if no industry is as hemmed in

with intellectual monopoly as the software industry. But it was not always like this. It turns out that over the last two decades, the software industry has "benefited" from massive changes in the law, legislated by that duly elected body, the U.S. Supreme Court. Indeed, prior to the 1981 U.S. Supreme Court decision in *Diamond vs Diehr,* it was not possible to patent software at all and the current craze to patent every click of the mouse originates in the subsequent extension of patents to software products in the 1994 Federal Circuit Court ruling *In re Alapat*.

Did this judicial legislation bring forth an explosion in software innovation? We mentioned Amazon suing Barnes and Noble over purchasing on line with just "one click." Some might wonder how difficult and innovative this invention is, so it may seem a straw man. Whatever the merits of "one click," there are certainly many software inventions that we all agree are important and innovative. There are all the graphical user interfaces, the widgets such as buttons and icons, the compilers, assemblers, linked lists, object oriented programs, databases, search algorithms, font displays, word processing, computer languages – all the vast array of algorithms and methods that go into even the simplest modern program. Not only are these innovations all difficult and important, the fact is that every single one of these innovations is used and is necessary to make the one click, or for that matter the "two click," work.

We do not mention any of these significant inventions as a consequence of patents into software innovation for one simple reason. Each and every one of these key innovations occurred prior to 1981 and so occurred without the benefit of patent protection. Not only that, had all these bits and pieces of computer programs been patented, as they certainly would have in the current regime, far from being enhanced, progress in the software industry would never have taken place. According to Bill Gates – hardly your radical communist or utopist – "If people had understood how patents would be granted when most of today's ideas were invented, and had taken out patents, the industry would be at a complete standstill today." [2]

Not only did patents play no role in software innovation, copyrights played only a limited role. While computer programs were often copyrighted, in the early years of the PC industry, copyright was seldom respected or enforced. Consumers would purchase programs and use them on a variety of computers in violation of license agreements. People bought and sold computer programs and created new ones by using bits and pieces, modules