

## 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.<sup>1</sup> 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."<sup>2</sup> 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.<sup>3</sup>

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.<sup>4</sup>

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.<sup>5</sup>

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.<sup>6</sup>

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.”<sup>7</sup>

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

was a wealthy man with strong connections in Parliament, was not a minor help.

Was Watt's patent a crucial incentive needed to trigger his inventive genius, as the traditional history suggests? Or did his use of the legal system to inhibit competition set back the industrial revolution by a decade or two? More broadly, are the two essential components of our current system of intellectual property – patents and copyrights – with all of their many faults, a necessary evil we must put up with to enjoy the fruits of invention and creativity? Or are they just unnecessary evils, the relics of an earlier time when governments routinely granted monopolies to favored courtiers? That is the question we seek to answer.

In the specific case of Watt, the granting of the 1769 and especially of the 1775 patents likely delayed the mass adoption of the steam engine: innovation was stifled until his patents expired; and few steam engines were built during the period of Watt's legal monopoly. From the number of innovations that occurred immediately after the expiration of the patent, it appears that Watt's competitors simply waited until then before releasing their own innovations. This should not surprise us: new steam engines, no matter how much better than Watt's, had to use the idea of a separate condenser. Because the 1775 patent provided Boulton and Watt with a monopoly over that idea, plentiful other improvements of great social and economic value could not be implemented. By the same token, until 1794 Boulton and Watt's engines were less efficient they could have been because the Pickard's patent prevented anyone else from using, and improving, the idea of combining a crank with a flywheel.

Also, we see that Watt's inventive skills were badly allocated: we find him spending more time engaged in legal action to establish and preserve his monopoly than he did in the actual improvement and production of his engine. From a strictly economic point of view Watt did not need such a long lasting patent – it is estimated that by 1783 – seventeen years before his patent expired – his enterprise had already broken even. Indeed, even after their patent expired, Boulton and Watt were able to maintain a substantial premium over the market by virtue of having been first, despite the fact that their competitors had had thirty years to learn how to make steam engines.

The wasteful effort to suppress competition and obtain special privileges is referred to by economists as rent-seeking behavior. History and common sense show it to be a poisoned fruit of legal monopoly. Watt's attempt to extend the duration of his

1769 patent is an especially egregious example of rent seeking: the patent extension was clearly unnecessary to provide incentive for the original invention, which had already taken place. On top of this, we see Watt using patents as a tool to suppress innovation by his competitors, such as Hornblower, Wasborough and others.

Hornblower's engine is a perfect case in point: it was a substantial improvement over Watt's as it introduced the new concept of the "compound engine" with more than one cylinder. This, and not the Boulton and Watt design, was the basis for further steam engine development after their patents expired. However, because Hornblower built on the earlier work of Watt, making use of his "separate condenser" Boulton and Watt were able to block him in court and effectively put an end to steam engine development. The monopoly over the "separate condenser," a useful innovation, blocked the development of another equally useful innovation, the "compound engine," thereby retarding economic growth. This retardation of innovation is a classical case of what we shall refer to as Intellectual Property-inefficiency, or IP inefficiency for short.

Finally, there is the slow rate at which the steam engine was adopted before the expiration of Watt's patent. By keeping prices high and preventing others from producing cheaper or better steam engines, Boulton and Watt hampered capital accumulation and slowed economic growth.

The story of James Watt is a damaging case for the benefits of a patent system, but we shall see that it is not an unusual story. A new idea accrues almost by chance to the innovator while he is carrying out a routine activity aimed at a completely different end. The patent comes many years after that and it is due more to a mixture of legal acumen and abundant resources available to "oil the gears of fortune" than anything else. Finally, after the patent protection is obtained, it is primarily used as a tool to prevent economic progress and hurt competitors.

While this view of Watt's role in the industrial revolution may appear iconoclastic, it is neither new nor particularly original. Frederic Scherer, a prestigious academic supporter of the patent system, after going through the details of the Boulton and Watt story, concluded his 1986 examination of their story with the following illuminating words

*Had there been no patent protection at all,...Boulton and Watt certainly would have been forced to follow a business policy quite different from that which they actually*

*followed. Most of the firm's profits were derived from royalties on the use of engines rather than from the sale of manufactured engine components, and without patent protection the firm plainly could not have collected royalties. The alternative would have been to emphasize manufacturing and service activities as the principal source of profits, which in fact was the policy adopted when the expiration date of the patent for the separate condenser drew near in the late 1790s.... It is possible to conclude more definitely that the patent litigation activities of Boulton & Watt during the 1790s did not directly incite further technological progress.... Boulton and Watt's refusal to issue licenses allowing other engine makers to employ the separate-condenser principle clearly retarded the development and introduction of improvements.*<sup>8</sup>

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The industrial revolution was long ago. But the issue of intellectual property is a contemporary one. At the time we wrote this, U.S. District Judge James Spencer had been threatening for three years to shut down the widely used Blackberry messaging network – over a patent dispute.<sup>9</sup> And Blackberry itself is not without sin: in 2001 Blackberry sued Glenayre Electronics for infringing on its patent for “pushing information from a host system to a mobile data communication device.”<sup>10</sup>

A similar war is taking place over copyright – the Napster network was shut down by a federal judge in July of 2000 in a dispute over the sharing of copyrighted files.<sup>11</sup> Emotions run high on both sides. We have the anti-copyright slogan “information just wants to be free” promoted by some civil libertarians. On the other extreme, large music and software companies argue that a world without intellectual property would be a world without new ideas.

Some of the bitterness of the copyright debate is reflected in Stephen Manes' attack on Lawrence Lessig

*According to Stanford law professor and media darling Lawrence Lessig, a “movement must begin in the streets” to fight a corrupt Congress, overconcentrated media and an overpriced legal system...Contrary to Lessig's rants... “Fair use” exceptions in existing copyright law...are so expansive that just about the only thing cut-and-pasters*

*clearly can't do legally with a copyrighted work is directly copy a sizable portion of it.*<sup>12</sup>

Certainly Lessig is no friend of current copyright law. Yet, despite Stephen Manes assertions to the contrary, he does believe in balancing the rights of producers with the rights of users: his book *Free Culture* speaks repeatedly of this balance and how it has been lost in modern law.<sup>13</sup>

Like Lessig, many economists are skeptical of current law – seventeen prominent economists, including several Nobel Prize winners, filed a brief with the U.S. Supreme Court in support of Lessig's lawsuit challenging the extension of the length of copyright. Also like Lessig, economists recognize a role for intellectual property: where lawyers speak of balancing rights, economists speak of incentives. To quote from a textbook by two prominent economists Robert Barro and Xavier Sala-i-Martin

*It would be [good] to make the existing discoveries freely available to all producers, but this practice fails to provide the...incentives for further inventions. A tradeoff arises between restrictions on the use of existing ideas and the rewards to inventive activity.*<sup>14</sup>

Indeed, while many of us enjoy the benefits of being able to freely download music from the internet, we worry as well how the musician is to make a living if her music is immediately given away for free.

While a furious debate rages over copyrights and patents, there is general agreement that some protection is needed to secure for inventors and creators the fruits of their labors. The rhetoric that “information just wants to be free” suggests that no one should be allowed to profit from her ideas. Despite this, there does not seem to be a strong lobby arguing that while it is ok for the rest of us to benefit from the fruits of our labors, inventors and creators should have to subsist on the charity of others.

For all the emotion, it seems both sides agree that intellectual property laws need to strike a balance between providing sufficient incentive for creation and the freedom to make use of existing ideas. Put it differently, both sides agree that intellectual property rights are a “necessary evil” that fosters innovation, and disagreement is over where the line should be drawn. For the supporters of intellectual property, current

monopoly profits are barely enough; for its enemies currently monopoly profits are too high.

Our analysis leads to conclusions that are at variance with both sides. Our reasoning proceeds along the following lines. Everyone wants a monopoly. No one wants to compete against his own customers, or against imitators. Currently patents and copyrights grant producers of certain ideas a monopoly. Certainly few people do something in exchange for nothing. Creators of new goods are not different from producers of old ones: they want to be compensated for their effort. However, it is a long and dangerous jump from the assertion that innovators deserve compensation for their efforts to the conclusion that patents and copyrights, that is monopoly, are the best or the only way of providing that reward. Statements such as “A patent is *the* way of rewarding somebody for coming up with a worthy commercial idea”<sup>15</sup> abound in the business, legal and economic press. As we shall see there are many other ways in which innovators are rewarded, even substantially, and most of them are better for society than the monopoly power patents and copyright currently bestow. Since innovators may be rewarded even without patents and copyright, we should ask: is it true that intellectual property achieves the intended purpose of creating incentives for innovation and creation that offset their considerable harm?

This book examines both the evidence and the theory. Our conclusion is that creators’ property rights can be well protected in the absence of intellectual property, and that the latter does not increase either innovation or creation. They are an unnecessary evil.

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This is a book about economics, not about law. Or put differently, it is not about what the law is but rather what the law should be. If you are interested in whether or not you are likely to wind up in jail for sharing your files over the internet, this is not the book for you. If you are interested in whether it is a good idea for the law to prevent you from sharing your files over the internet, then this book is for you.

However, while this book is not about the law, some background on the law is necessary to understanding the economic issues. We are going to examine the economics of what has, in recent years, come to be called “intellectual property,” especially patents and copyright. In fact, there are three broad types of

intellectual property recognized in most legal systems: patents, copyrights and trademarks.

Trademarks are different in nature than patents and copyrights: they serve to identify the providers of goods, services or ideas. Copying – which would be a violation of copyright – is quite different from lying – which would be a violation of trademark. We do not know of a good reason for allowing market participants to steal identities or masquerade as people they are not. Conversely, there are strong economic advantages in allowing market participants to voluntarily identify themselves. While we may wonder if it is necessary to allow the Intel Corporation a monopoly over the use of the word “inside,” in general there is little economic dispute over the merits of trademarks.

Patents and copyrights, the two forms of intellectual property on which we focus, are a subject of debate and controversy. They differ from each other in the extent of coverage they provide. Patents apply to specific implementations of ideas – although in recent years in the U.S. there has been decreasing emphasis on specificity. Patents do not last forever: in the United States, 20 years for patents covering techniques of manufacture, and 14 years for ornamentation. Patents provide relatively broad protection: no one can legally use the same idea, even if they independently rediscover it, without permission from the patent holder.<sup>16</sup>

Copyrights are narrower in scope, protecting only the specific details of a particular narrative – although as with the case of patents, the scope has been increasing in recent years. Copyright is also much longer in duration than patent – the life of the author plus 50 years for the many signatory countries of the Berne Convention, and – in the U.S. since the Sonny Bono Copyright Term Extension Act – the life of the author plus 70 years.<sup>17</sup>

In the U.S. there are limitations on copyright not present in patent law. As Stephen Manes correctly points out in his attack on Lawrence Lessig, the right of fair use allows the purchaser of a copyrighted item limited rights to employ it, make partial copies of it and resell them, regardless of the desires of the copyright holder. In addition, certain derivative works are allowed without permission: parodies are allowed, for example, while sequels are not.

In the case of both patents and copyright, from the point of view of economics, there are two ingredients in the law: the right to buy and sell copies of ideas, and the right to control how other people make use of their copies. The first right is not controversial.



In copyright law, when applied to the creator this right is sometimes called the “right of first sale.” However, it extends also to the legitimate rights of others to sell their copies. It is the second right, enabling the owner to control the use of intellectual property after sale, that is controversial. This right produces a monopoly – enforced by the obligation of the government to act against individuals or organizations that use the idea in ways prohibited by the copyright or patent holder.

In addition to the well-known forms of intellectual property – patents and copyright – there are also lesser-known ways of protecting ideas. These include contractual agreements, such as the shrink-wrap and click-through agreements that you never read when you buy software. They also include the most traditional form of protection – trade secrecy – as well as its contractual and legal manifestations such as non-disclosure agreements. Like patents and copyright all of these devices serve to help the originator of an idea maintain a monopoly over it.

We do not know of any legitimate argument that producers of ideas should not be able to profit from their creations. While ideas could be sold in the absence of a legal right, markets function best in the presence of clearly defined property rights. Not only should the property rights of innovators be protected but also the rights of those who have legitimately obtained a copy of the idea, directly or indirectly, from the original innovator. The former encourages innovation, the latter encourages the diffusion, adoption and improvement of innovations.

Why, however, should creators have the right to control how purchasers make use of an idea or creation? This gives creators a monopoly over the idea. We refer to this right as “intellectual monopoly,” to emphasize that it is this monopoly over all copies of an idea that is controversial, not the right to buy and sell copies. The government does not ordinarily enforce monopolies for producers of other goods. This is because it is widely recognized that monopoly creates many social costs. Intellectual monopoly is no different in this respect. The question we address is whether it also creates social benefits commensurate with these social costs.

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The U.S. Constitution allows Congress “To promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective

writings and discoveries.”<sup>18</sup> Our perspective on patents and copyright is a similar one: promoting the progress of science and the useful arts is a crucial ingredient of economic welfare, from solving such profound economic problems as poverty, to such mundane personal nuisances as boredom. From a social point of view, and in the view of the founding fathers, the purpose of patents and copyrights is not to enrich the few at the expense of the many. Nobody doubts that J. K. Rowling and Bill Gates have been greatly enriched by their intellectual property – nor is it surprising that they would argue in favor of it. But common sense and the U.S. Constitution say that these rights must be justified by bringing benefits to all of us.

The U.S. Constitution is explicit that what is to be given to authors and inventors is an exclusive right – a monopoly. Implicit is the idea that giving this monopoly serves to promote the progress of science and useful arts. The U.S. Constitution was written in 1787. At that time, the idea of copyright and patent was relatively new, the products to which they applied few, and their terms short. In light of the experience of the subsequent 219 years we might ask: is it true that legal grants of monopoly serve to promote the progress of science and the useful arts?

Certainly common sense suggests that it should. How is a musician to make a living if the moment she performs her music, everyone else can copy and give it away for free? Why would the large corporations pay the small inventor when they can simply take his idea? It is hard to imagine life without the internet, and today we are all jet setters. Is not the explosion of creativity and invention unleashed since the writing of the U.S. Constitution a testimony to the powerful benefit of intellectual property? Would not the world without patent and copyright be a sad cold world, empty of new music and of marvelous new inventions?

So the first question we will pose is what the world might be like without intellectual monopoly. Patents and copyrights have not secured monopolies on all ideas at all times. It is natural then to examine times and industries in which legal protection for ideas have not been available to see whether innovation and creativity were thriving or were stifled. It is the case, for example, that neither the internet nor the jet engine were invented in hopes of securing exclusive rights. In fact, we ordinarily think of “innovative monopoly” as an oxymoron. We shall see that when monopoly over ideas is absent, competition is fierce – and that as a result innovation and creativity thrive. Whatever a world without

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.<sup>19</sup> 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].”<sup>20</sup>*

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**

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<sup>1</sup> Lord [1923] p. 5-3.htm.

<sup>2</sup> Carnegie [1905] p. 157.

<sup>3</sup> 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](http://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.

<sup>4</sup> 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].

<sup>5</sup> 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.

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

<sup>7</sup> Thompson [1847] p. 110 and quoted also in Lord [1923].

<sup>8</sup> Scherer [1984] pp. 24-25.

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

<sup>10</sup> U.S. Patent 6219694.

<sup>11</sup> United States Court of Appeals for the 9<sup>th</sup> Circuit Court, In Re: Napster.

<sup>12</sup> Stephen Manes [2004] .

<sup>13</sup> Lessig [2004].

<sup>14</sup> Robert Barro and Xavier Sala-i-Martin [1999] p. 290.

<sup>15</sup> *The Economist*, June 23<sup>rd</sup> 2001, page 42, with italics added.

<sup>16</sup> Information on U.S. Patent Law can be found at the U.S. Patent Office at [www.uspto.gov/main/patents.htm](http://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.

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

<sup>18</sup> 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>.

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

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