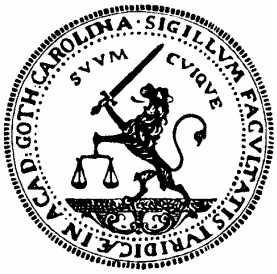

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The patent systems of today – at a crossroad

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Contents

Summary

In recent years, the number of patent filings has risen dramatically. This increase is due to several factors, such as, emergence of new technologies, increasing importance of patent portfolios, strategic patenting and pro-patent views among policy makers. The rise in the number of patents has been accompanied by a growing importance of patent licensing and patent lawsuits. Today's patent systems create obstacles for future innovation and we are standing at a crossroad when it comes to creating future incentives to innovate. This thesis applies the method of law and history, to highlight important stages of the development of patents and to put current events in a historical perspective, and the method of law and economics, to consider how the objectives of patents are compromised and if it is to such an extent that the costs patents impose on society are greater than the benefits.

The first patent-like grants are to be found in the 14th and 15th century in England. The historical development of patents has thereafter followed in the steps of technological change and industrial progress, but the development of patents has not been linear. This means that even though patents have gone towards stronger and broader rights their existence have been contested throughout history. The historical development has also been accompanied by efforts of harmonization, initially on a European level and currently on a global level. From a historical perspective it can be argued that it is not reasonable to enforce current patent standards on developing countries. Many developed countries have benefited from weak patent protection when they were at similar stages of economic development.

From an economic perspective patents are suppose to create incentives to invent, induce disclosure and stimulate trading with inventions. The benefits of these objectives are compromised by a number of factors which impose costs on society, namely, monopolistic markets, impeded cumulative innovation, strategic patenting and strategic litigation. This thesis concludes that many of the factors compromising the benefits of patents are products of the current patent environment, or at least worsened by it. The costs of the patent systems would be alleviated if the number of patents of questionable quality was significantly reduced. This could be achieved by raising the inventive step of patents. This thesis also considers whether changes in patent breadth and duration could further lessen the costs without reducing the benefits. It is concluded that if no distinction is made between various products, then patents of medium breadth and medium length is the most favourable option from a cost-benefit perspective. However, if a distinction is made it would be favourable to offer patents with various lengths and breadths, at least theoretically. The cost-benefit perspective is also applied at the issue of global harmonization and it is concluded that whether patent protection should be extended or not depend on the level of economic development in developing countries.

Abbreviations

CAFC	Court of Appeals for the Federal Circuit
EPC	European Patent Convention
EPO	European Patent Office
FDI	Foreign direct investment
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
IPC	International Property Committee
IPRs	Intellectual Property Rights
LDC	Least developed countries
PCT	Patent Cooperation Treaty
R&D	Research and Development
TT	Technology transfer
TRIPS	Agreement on Trade-Related aspects of Intellectual Property Rights
US	United States of America
USC	United States Code
USPTO	United States Patent and Trademark Office
USTR	United States Trade Representative
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Preface

In the summer of 2007, the summer before I began writing my thesis, I was taking summer courses at Harvard University. On the list of obligatory literature for my course in intellectual property, there was a book by Jaffe and Lerner by the name “Innovation and its discontent”. This book gave a lucid and engaging description of how the US patent system worked, what was wrong with it and how it should be improved. Our professor, Prof. Ryan, considered this to be one of the most important books written in the last couple of years. With this book and Prof. Ryan’s lectures in mind I became interested in learning more about the actual functioning of the patent systems in the US and Europe. It took me some time to come up with the proper scope of my thesis. I made many attempts at finding a more narrow approach to the subject, but I found myself constantly returning to and being intrigued by the broader questions and I therefore decided to follow my first intention.

Lastly, I wish to express my gratitude to my family and friends for their never-ending support and encouraging words along the writing of this thesis.

Anna-Karin Abdon

1 Introduction

”We can't reject something just because it's stupid”
Esther M. Kepplinger, Deputy Commissioner of the U.S Patent and Trademark Office.[1]

In 2001, Albie's Foods, a small grocery and caterer in northern Michigan, received a letter stating that they were infringing on a patent belonging to the giant jam and jelly maker J. M Smucker Co. The patent in question was ”a sealed crustless sandwich”, granted in 1999 by the U.S Patent & Trademark Office (USPTO) and Albie's Foods were currently selling crustless peanut butter and jelly sandwiches.[2] J. M Smucker Co. had been granted a broad patent covering the following: ”The sandwich includes a lower bread portion, an upper bread portion, an upper filling and a lower filling between the lower and upper bread portions, a center filling sealed between the upper and lower fillings, and a crimped edge along an outer perimeter of the bread portions for sealing the fillings there between. The upper and lower fillings are preferably comprised of peanut butter and the center filling is comprised of at least jelly.”[3] This alleged infringement led to three different proceedings: J.M Smucker Co. sued Albie's Food for patent infringement. Albie's Foods sued J.M Smucker Co. requesting patent invalidation and made a request for re-examination in the USPTO. The patent was eventually voided on the grounds of being obvious or lacking an inventive step.[4]

This example of a poor-quality patent is quite amusing, but these kinds of patents can have serious consequences when the patent holder sues to enforce them. The PB&J sandwich patent is just one of many patents indicating that the patent system is standing at a crossroad. How could the patent have been granted in the first place? The number of patent filings has increased dramatically in the last decade. The European Patent Office (PTO) received 200,000 patent applications in 2006 as compared to 80,000 in 1995, which is an increase by 150%.[5] The USPTO experienced an even greater increase. In 1995, 235,000 patent applications were filed and in 2007, the corresponding figure was 465,000, which is an increase by almost 200%.[6] The high number of patent filings depends on a number of reasons and the following are some of the most important: emergence of new technologies, increasing importance of patent portfolios, strategic patenting and pro-patent views among policy makers. As the numbers of patents are increasing so is the amount of licensing contracts and lawsuits. Today patent licensing is a business that turns over more than US$100 billion worldwide.

[1] Sag and Rohde, 2007, p.2
[2] Jaffe and Lerner, 2007, p. 25.
[3] US Patent Nr: 6004596
[4] http://www.clevescene.com/2005-04-20/news/the-peanut-butter-jam/
[5] Guellec and van Pottelsberghe de la Potterie, 2007, p. 8.
[6] http://www.uspto.gov/web/offices/com/annual/2007/50302_table2.html

The number of patent lawsuits, especially in the US, has risen as rapidly as the patent filings.[7] It is easy to argue that the patent system is facing problems which it has not been equipped to handle.

Intellectual Property Rights (IPRs) have become one of the companies' of today most valuable assets. Some companies apply for patents as a preventive measure to avoid being sued for infringement. Others agree in fear of litigation on a licensing contract instead of developing their own products. Companies, nicknamed patent trolls, make money on patents only through litigation and licensing and not from manufacturing or improving the invention on which they hold a patent. At the same time as the number of patent filings is higher than ever and patents are granted in fields we had little knowledge of 20 years ago, we are also facing ethical dilemmas by the patenting of life forms. The feeling of a crisis in the US as well as in Europe is widespread in contemporary literature. The patent systems of today are standing at a crossroad. We can either choose to continue in the direction which we are currently heading or we could choose a new direction. The choice we make will most likely have serious effects on the innovative climate. This thesis argues that we should choose the later option.

1.1 Purpose and method

The purpose of this thesis is to examine the patent systems of today in order to clarify how the patent system have gone wrong and provide a starting-point for further debates of improvement. This is achieved by studying the legal field of patents using the methods of law and economics and law and history. Why is it important to consider patents from an economical perspective? The objective of the patents is to foster innovation and growth. Inventors are given incentives to invent through grants on time-limited monopolies in return for disclosure to the public. For many years, scholars have recognized the importance of that an invention must be beneficial to the public if it should be rewarded with a patent. Otherwise, it can be too socially costly when considering that excessive rewards to patentees could hamper further innovation and competition. Yet, it seems as this economic aspect of patents is far too often neglected. The method of law and economics is presented thoroughly in chapter 3.

The chapter on the historical development of patents aims at highlighting trends and crosscurrents of the historical development of patents. It puts the patent systems of today in its historical contexts. The historical development of patents shows that the history of patents is far from linear and that the inherent tension in patents, the owning of knowledge which excludes others, reoccurres throughout history. The historical development also shows that the design of patents has never been random, but rather a reaction to previous patent design and current developments in society.

[7] Jaffe and Lerner, 2007, p.12

IPRs have been the subject of international harmonization for a long time, but it is first in recent years the efforts have intensified. The harmonization is largely initiated by the western world and diverging opinions exist on how much consideration should be taken to the level of economic development that the developing countries have reached. Special attention is given to the development of patents in developing countries in this thesis.

To fulfil the purpose of this thesis the following questions are answered during the course of the thesis:

1. How have the patent systems developed?
2. What are the objectives of patents and how are they compromised?
3. Are the benefits of patents greater than the costs they impose on society?
4. If the historical and economical aspects of patents are taken into account, is it reasonable to extend and enforce patent systems on developing countries?

The scope of this thesis is fairly broad, but necessary to give the conclusive background on which decisions for future changes of the patent system should be made. The more narrow approach to different aspects of patent law is of course of great importance, but we must not forget to look at legal institutions from a broader perspective and from time to time re-evaluate their existence.

1.2 Delimitations

The reader must keep in mind that the subject matter is discussed from a principal point of view. Therefore, laws and regulations as well as case law are not discussed in detail. Furthermore, the thesis does not aim at providing a complete set of solutions for future changes of the patent system. Rather it presents what should be considered before making any changes and some recommendations for the future. Due to the scope of this thesis and the limited number of pages, the historical and economical accounts are not completely exhaustive.

The thesis is limited to the European and the US patent system and international harmonization, which foremost leaves out the development of patents in other developed countries, such as Japan.

In section 5.4 where theories of optimal patent design are presented, they only cover the breadth and duration of patents, not patentable subject matter.

1.3 Literature

The state of the patent systems in Europe and the US is a topic of current debate, which has intensified during the last decade. Consequently, there is a great number of articles available discussing the problems. Most of them

cover a delimited part of the problems and a majority of articles focus on the state of the US patent system. The debate in the US has been more intense and going on for a longer period. This is largely due to that the problems facing the US patent system are more severe than the ones facing Europe.

There are also some important books covering the field. Jaffe and Lerner's book ”Innovation and its discontent” have served as a great source of inspiration for choosing this topic. For the historical account “Intellectual property rights – a critical history”, by May and Sell have been of great importance. For the economic approach Scotchmer’s ”Innovation and Incentives” give a very exhaustive account of the US patent system. The closest equivalent covering Europe is found in Guellec and van Pottelsberghe de la Potterie's book, ”The economics of the European Patent System”. It was published in 2007 and is the first of its kind, addressing economical aspects of the patent system in Europe.

1.4 Disposition

Chapter 2 answers question number 1 and highlights the trends in patent systems of different countries and eras. This chapter also answers partly question number 4. It is concluded with an analysis of the presented material. Chapter 3 covers basic concepts in law and economics, relevant to the following chapter. Chapter 4 examines the economics of patents and takes into consideration the objectives of patents and how they are compromised, consequently answering question number 2. This chapter is also concluded with an analysis, which brings an answer to question number 3 and 4. The final chapter, chapter 5, provides some conclusive comments on the future of patents.

1.5 Patent basics

Before the historical and economical accounts are given, some basic facts on patents are presented. More specifically, prerequisites for patentability, patentable subject matter, what rights a patent gives a patentee, and finally, some information on the patent application procedure. Readers already well acquainted with these subjects can continue on to chapter 2.

The prerequisites for patentability are to be found in Article 52 in the European Patent Convention (EPC) and in Title 35, United States Code (USC) sections 101-103. According to Article 52 in the EPC, an invention, which is considered new, involve an inventive step, and capable of industrial application can be patented. According to Title 35, United States Code (USC) sections 101-103, the patentability requirements are new, useful and non-obvious. The term new has similar meanings in both the EPC and the USC referring to that an invention cannot be previously known. Inventive step and non-obviousness refers to that it is not enough that an invention is novel; it has to be some technical advancement over the

state of the art.[8] According to Article 57 in EPC, industrial application refers to that an invention "has to be made or used in any kind of industry, including agriculture." The term useful has devolved to a rather insignificant prerequisite for patentability. An invention does not need to have any proven use in a factory. Inventions that only work in an experimental setting are rewarded with patents.[9]

In Article 52 of the EPC inventions can be granted in any field of technology, but there are certain exceptions. Discoveries, scientific theories, mathematical theories, aesthetic creations, schemes, rules and methods of performing mental acts, playing games or doing business, programs for computers and presentations of information cannot be patented. According to the US statute section 101, an invention or a discovery, which is a process, machine, manufacture, or composition of matter, or improvements thereof, is patentable. The word "process" is defined by law as a process, act or method, and primarily includes industrial or technical processes. The term "machine" used in the statute needs no explanation. The term "manufacture" refers to articles that are made, and includes all manufactured articles. The term "composition of matter" relates to chemical compositions and may include mixtures of ingredients as well as new chemical compounds. These classes of subject matter taken together include practically everything that is made by man and the processes for making the products."[10] Interpretations of the US statute have clarified a number of exemptions to patentable subject matter, more explicitly, the laws of nature, physical phenomena, and abstract ideas.[11]

Patents give their owners the right to exclude others from making, using, selling, offering for sale, or importing for these purposes the patented product during a time period of 20 years.[12] The rights conferred by a patent only apply for the country or countries where the patent has been granted.[13] If someone else uses a patent without permission from the patent holder it constitutes infringement. The patent holder can grant someone else the right to use his patent through a license.[14]

In the US, patents are only granted to the first inventor, while in Europe, patents are granted to the first person to file a patent application. Applications can be made in national patent offices around the world for a patent valid in that or those countries, at the EPO for a patent valid in European countries by choice of the applicant, or an international patent application through the Patent Cooperation Treaty (PCT), which can be applied for in domestic patent offices or at the World Intellectual Property

[8] Guellec and van Pottelsberghe de la Potterie, 2007, p. 133.
[9] Merges et al., 2006, p. 124.
[10] General information concerning patents. Available at: http://www.uspto.gov/web/offices/pac/doc/general/index.html#whatpat
[11] General information concerning patents. Available at: http://www.uspto.gov/web/offices/pac/doc/general/index.html#whatpat
[12] Mergers et al., 2006, p. 126.
[13] Guellec and van Pottelsberghe de la Potterie, 2007, p. 5.
[14] Jaffe and Lerner, 2007, p. 31.

Organisation (WIPO). The first application made at any patent office around the world on an invention is called *a priority application.* Such an application is given *a priority date*, which is important when applying for subsequent patents in other countries. The PCT grants the patentee one year from the priority date to file for patents in other signature countries. WIPO has a corresponding time for priority filing of 30 months.[15]

[15] Guellec and van Pottelsberghe de la Potterie, 2007, pp. 156-158.

2 Historical development of patents

This chapter is not an exhaustive account of the patent history from early societies up until today. Instead it highlights important events and crosscurrents that have had a determining effect on patent systems in specific countries or the patent systems in general.

2.1 Early patent history

The conduct of trying to control valuable knowledge and information is much older than any formal legal definition of intellectual property. The Greek and Roman societies, as well as the medieval guilds and artisans, mainly relied on the use of an early form of trademark for protection. Patent-like grants are first to be found in the 14th and 15th century. They were privileges given by the British king, who granted monopoly to persons introducing processes or practices previously unknown in the British territory.[16] John Kempe, a Flemish weaver received protection for introducing his art, as well as John Shiedame for bringing the newly invented process of manufacturing salt to England. The purpose of these grants was to encourage the migration of skilled artisans to the country and eventually reduce imports and expand exports.[17] Therefore, the persons who were given the grants had to agree on the conditions to actually work their invention in the country and teach it to others.[18]

The first monopoly grant on an invention, as compared to the grants on introduction above, was granted to Filippo Brunelleschi in 1421 in Florence. He had invented a vessel to transport heavy goods more cheaply on the Arno River. In his petition the demands were clear: "(The petitioner) refuses to make such machine available to the public in order that the fruit of his genius and skill may not be reaped by another without his will and consent, and that, if he enjoyed some prerogative concerning this, he would open up what he is hiding and would disclose it to all."[19] This prototypical patent had a very wide scope but was limited in time to only three years. Interestingly, it was also primarily supported on the notion of being a novelty. The vessel eventually sank on its maiden voyage due to unknown reasons. The Florentine authorities did not grant any new patents after this incident for another 50 years and their practice was never formalized in a legal statute.[20]

[16] May and Sell, 2006, pp. 44-48.
[17] Ibid. p. 52-53.
[18] Liebesny, 1972, p. 6.
[19] David. 1992, p. 9.
[20] Mgbeoji, 2003, pp. 411-412.

2.1.1 Venice – the first patent law

The first formal institutionalization of intellectual property was done in Venice in 1474. For the first time, patents were subject to generalized law instead of a process of individual request and grant. Focus was on an applicant's ability to fulfil certain fixed criteria. The statute of 1474 offered protection for a period of ten years if the invention passed the examination of the General Welfare Board. According to the statute, grants were given if the invention was not previously known within the territory of the republic and if it had been perfected so it was possible to use. The statute made it possible to license the invention to someone else and also contained a working requirement, which made it possible for the state to retain a compulsory license if the invention was not put to use within a certain term.[21].

Notably, it appears as very few patents were issued under the statute in the following couple of decades. Specific grants of monopolies, of the same kind as mentioned in this chapter's first paragraph, continued to be the most important form of protection for inventions.[22] These *privilegis*, the Venetian term, were exclusive production and trade rights ranging in protection between 5 and 80 years, which could be revoked if they were considered of socioeconomic importance to the state. The privilegi on "glasses for the eyes" is one example of an invention which was revoked for the benefit of the public.[23]

2.1.2 Some continental developments

By the middle of the 16th century, the way Venice granted protection on inventions was becoming known throughout Europe. Declining commerce in the Italian Peninsula and persecution by the Roman Catholic Church of Italian artisans and inventors, known for their unorthodox religious, scholarly and scientific beliefs, led many Italian artistans to pursue more favourable market conditions and personal safety in different countries around continental Europe.[24] These emigrants sought monopolies in their adopted countries, accustomed to the ability to protect their inventions.

The French crown as well as the government of the Netherlands awarded a number of grants during the second half of the 16th century to both migrants and nationals as an instrument of mercantilist policy. Novelty was still geographically specific.[25] The Venetian practice was also to be found in Germany and was improved in the sense that the majority of patents were given to true technological improvements, not just patents of importation.[26] Germany also had some form of patent examination and besides novelty and

[21] May and Sell, 2006 pp. 58-61.
[22] David, 1993, p.10.
[23] May and Sell, 2006, pp. 58-60.
[24] Mgbeoji, 2003, pp 415.
[25] May and Sell, 2006, p. 76.
[26] Flynn, 2006, pp. 10-11.

utility, the granting practice shows evidence of that a public-regarding aspect was taken into account. [27]

2.1.3 Patents in England

The practice of granting patent monopolies in England became firmly established first under the reign of Elizabeth I. The Queen and her chief minister, William Cecil, found it troublesome that England was lagging behind industrially compared to continental Europe. Patents became a part of a national industrial policy. The purpose was to attract foreigners with the practical skills, in which the English industry were deficient, and eventually make the country self-sufficient. However, the policy was not carried out in the most successful way. While many of the patents were granted on inventions for new industries, some were given to already established industries.[28] By the end of the 17th century, starch, salt, paper, and glass were controlled by patent monopolies, which led to an enormous inflation in prices. This situation caused vigorous debates in the House of Commons and eventually, the Queen issued a proclamation revoking the patents which were the most questionable.[29] The abuse of patents continued with Elizabeth I's successor, James I. Products such as tobacco, cloth, butter, fish, dyestuff, and raisins and processes such as shipping, lighthouses, inns and alehouses and transporting silver were granted patent protection during his reign. This eventually moved Parliament to enact the Statute of Monopolies in 1624.[30]

According to the Statute of Monopolies patents could be granted for a period of 14 years to the first and true inventor. This included first importation to England as well. The patent duration was set to 14 years since that was equal to two periods of apprenticeship. It was important to be able to spread the knowledge within the country after the period of patent protections was over. The invention could not be contrary to law, which meant that it had to be an innovation of some sort, a mere improvement of a product or a process was not enough. Neither could the innovation be hurtful to trade nor "generally inconvenient". The statute also contained a condition stating that a patent on an invention was not valid if it caused higher prices on commodities at home. Patents were granted "by the grace of the Crown", which made it possible for the state to revoke them under above mentioned circumstances.[31] After the Statute of Monopolies was passed, it took 200 years before there was further legislation on patents in England. The development of the patent system during this period was due to the work of lawyers and the courts,[32] but it has to be taken into account that the Privy Council, a committee of the monarch's closest advisors, did

[27] May and Sell, 2006, p. 77
[28] Liebesny, 1972, p. 6
[29] May and Sell, 2006, pp 81-82.
[30] Flynn, 2006, pp. 32-33.
[31] May and Sell, 2006, pp. 82-83.
[32] Liebesny, 1972, p. 7

not leave rulings over patents in the jurisdiction of the common law courts until 1752.[33]

The operation of the patent system was in the hands of the Law officers of the Crown and the procedure to obtain a patent was very complex. The inventor or his agent had to visit seven different offices and the personal signature of the Sovereign was required in two of these offices. If the inventor wished to hold a patent in Scotland and Ireland as well, the application had to be negotiated at five additional offices in each country. This administrative procedure was very time consuming as well as very costly. These two factors contributed to that the majority of those who filed for patents were persons with wealth and political connections and this inhibited the diffusion of information. In much, the patent system continued to be a system of privileges.[34] It should also be noted that the statute did not contain any prerequisite about specifying the invention when applying for a patent. Specifications became more common in the 18th century, but examination rather than registration became mandatory first in the Patent Act of 1883. It was left to the courts to settle disputes concerning disagreements on the validity of grants.[35]

The Statute of Monopolies was far from a completely developed piece of legislation and its deficiency became even more obvious during the industrial revolution. England was in the leading position during the industrial revolution, roughly between the 1780s and the 1840s. Their mining and steam engine technology, as well as the mechanization of the textile industry made them industrially superior to other countries.[36] As the ways to communicate and spread knowledge became easier, the awareness of the patent system's existence increased. Consequently, a larger number of products and processes were being patented. To not lag behind in the industrial race many applied for patents as a preventive measure before an "imposter" did. Patents were becoming highly profitable.[37] Since the procedure to obtain a patent was essentially a registration routine and no examination of novelty, the patentee had no assurance that his patent would uphold if tried in court. Patents of great importance often ended up as subjects of infringement suits. Infringement suits were very time consuming and costly.[38]

In the years before and during the Industrial Revolution, there were growing ideas on the justification of the protection of patents. Some considered inventions as acts of geniuses and monopolies interrupting the free market were justified on the grounds that inventors should benefit from their work. It was the inventors' natural right.[39] Others, basing their opinions on

[33] May and Sell, 2006, p. 87
[34] Khan, 2008, pp. 1-2.
[35] May and Sell, 2006, p. 85
[36] Sell, 2004, p. 283.
[37] May and Sell, 2006, p. 86
[38] Flynn, 2006, pp. 41-42.
[39] Ibid, pp 42-43.

utilitarian arguments, considered patents to be a matter of public policy and that the granting of patents should promote public good. Patents were social institutions to encourage creativity and diffusion of knowledge. This tension between the private right to reward and what benefits the collective is a continuing feature throughout the patent history.[40]

2.1.4 Early American patents

The English settlers on the North American continent were accustomed to the Statute of Monopolies and began to raise their voices for similar patent monopolies. By the 1640s, many American colonies had adopted legislation similar to the Statute of Monopolies. After the American War of Independence, the granting of patents as a favour by the Crown was replaced by natural rights ideas. An inventor had a natural right to his property. By the time the Constitution was drafted, the different colonies agreed on that a common patent law for all colonies would be more efficient.[41] In 1789 the foundation of US patent and copyright law was laid down through the adoption of Article 1, section 8, 8th clause: "The Congress shall have the power... 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."[42]

In 1790, Congress passed the first United States Patent Act. Patents were granted for fourteen years to "any useful art, manufacture, engine, machine, or device of any improvement therein not before known"[43] Inventions had to pass a novelty examination by a board of patent examiners. Inventions had to be truly novel; patents on imported discoveries were not patentable.[44] This examination process proved to be too time consuming and in 1793 a new patent act was adopted where the granting of patents became a mere registration procedure and the Secretary of State issued patents without any prior examination of novelty. It was instead left to the courts to settle questions of novelty. This eventually led to complaints about the quality of patents and with a new patent act in 1836 examinations of novelty prior to the granting of patents were reinstated. A newly set up Patent Office became in charge of the novelty examination.[45]

Another interesting aspect of the American patent system was the fact that between 1793 and 1836 it was only possible to receive a patent if you were an American citizen or intended to become one. Americans could therefore use foreign inventions without paying any licensing costs or similar costs, which would have been the case if foreigners could obtain patents.[46] With the patent act of 1836 foreign citizens were permitted to patent in the US,

[40] May and Sell, 2006, pp. 108-109.
[41] Liebesny, 1972, p. 11.
[42] Flynn, 2006, p. 69.
[43] Liebesny, 1972, p. 11.
[44] Khan, 2008, p. 5.
[45] Flynn, 2006, pp. 75-76.
[46] Khan, 2008, p. 5.

but with filing fees much higher than for American citizens. The fee for American citizens was $30 while it cost British citizens $500 and other foreigners $300. The Senate justified these fees with reference to the principle of reciprocity.[47] Foreigners also had to obey by the rule to put their products up for sale to the public "at a reasonable price"; otherwise their patents were not enforceable.[48]

2.1.5 Patents in France

Patent privileges granted by the king came to an end with the French Revolution. Soon after, the discontent among inventors grew and in 1791 they petitioned the National Assembly for a patent law using the British system as an example. In the same year, the assembly passed a patent law. In comparison to the English patent law, it was not resting on the notion that a patent was an act of grace by the crown, but instead that inventions were property and that the right to one's property was one of the fundamental rights of man. It is the same philosophical foundation that can be found in contemporary American patent law.[49]

The patent law of 1791 required that an invention passed a novelty examination, but this was removed with the patent law of 1844 and left it up to the courts to decide whether an invention was novel or not. The government wanted to limit the international diffusion of French inventions and if a French citizen filed a patent on an invention in a foreign country, he lost his patent protection in France. The French government was, however, interested in foreign inventions and granted patents on inventions of importation.[50]

2.2 19th century

By the beginning of the 19th century most industrialized European countries had patent laws. Most countries' patent laws had the requirement that an invention had to be truly new to be granted a patent, in comparison to England and France. The enactment of these laws was the result of the increasing awareness of the growing value of patents. Many industrialists lobbied for stronger and broadened patent rights.[51]

2.2.1 The patent controversy

Between 1850 and 1875, anti-patent movements were spreading around Europe. In 1850 in England, *The Economist* declared that England's patent laws were "... unnecessary for the continuation of the nation's commercial

[47] Reciprocity refers, in this context, to the conduct of state A to treat citizens of state B the way that B treats the citizens of state A.
[48] Flynn, 2006, p. 77.
[49] Liebesny, 1972, pp. 12-13.
[50] Khan, 2008, p. 2.
[51] Liebesny, 1972, pp. 13-14.

supremacy and actually harmful to it."[52] Even several members of Parliament argued in favour of the abolition of patents based on the principle of free-trade. Others urged for reform of the current patent system instead of abolition. The abolitionists were never able to come up with a workable alternative to patents and the reformist's ideas instead formed the basis for a new patent law in 1883.[53] The most substantial change in the new law was a patent application process with fewer steps and lowered patent fees. A novelty requirement was not made statutory until 1902.[54]

The debate over patents and free-trade took place in continental Europe as well. In Germany, the Congress of German Economists stated that "patents of invention are injurious to common welfare".[55]The opponents to patents around Europe supported their cause with several arguments. Firstly, patents did not work as incentives, but were in fact disincentives to rivals as soon as the first inventions had been granted patents. Secondly, they believed that rewards for an invention was just to some extent, but argued that the rewards were rarely distributed fairly. Thirdly, they maintained that people had been inventive throughout history even when the prospect of receiving a patent was nonexistent. Lastly, the fact that patents were not available in some countries had given those countries an unjust advantage and it was therefore better if patents were banned all together in favour of free trade.[56]

The abolitionist movement achieved their greatest success in the Netherlands where the patent law of 1817 was revoked in 1869. The law of 1817 had allowed patents of importation. During the period 1851-65, 90% of all patents were granted on imported goods; Dutch inventive activity was low. The Netherlands eventually succumbed to international pressure and introduced a patent system in 1913. In the no-patent period, the Netherlands benefited from the possibility to free-ride on inventions from other countries as well as domestic inventions.[57] After a patent system was reinstated it was again foreigners who benefited the most on its existence and in 1913, 80% of the patents issued were granted to foreigners.[58] Switzerland, on the other hand, had never had a patent law. Two referendums on the matter, in the 1866 and 1882, had been defeated. A couple years after the last referendum a partial patent law was accepted, but Switzerland did not adopt a patent law similar to other European countries until 1907.[59] The decision to adopt the patent law was, just like in the case of the Netherlands, mainly due to international pressure. Germany had threatened to raise duties on imported goods from Switzerland if Switzerland did not change its patent laws.[60]

[52] Flynn, 2006, p. 105.
[53] Flynn, 2006, 105.
[54] Khan, 2008, p. 2.
[55] Ibid. p. 4.
[56] May and Sell, 2006, p. 115.
[57] Flynn, 2006, pp. 106-107.
[58] Khan, 2008, p. 4.
[59] Flynn, 2006, pp. 106-108.
[60] Pugatch, 2004, pp. 65-66.

Consequently, the proponents of intellectual property protection won the battle against the free trade advocates around Europe as well. This was the beginning of an era that justified intellectual property rights as an acceptable and lawful form of monopoly. For a century to come, the divergence between intellectual property rights and international trade would be absent in the mainstream debate.[61]

2.2.2 Harmonization

Until 1883, the advancement of patent systems had taken place only on a national level and on the international market inventors faced great difficulties if they wanted to protect their inventions. In most industrialized countries, novelty had become a condition for receiving a patent, but the opinion on what novelty constituted differed. In France, Italy, Spain and Sweden, for example, previous publication of an invention anywhere in the world made the granting of a patent impossible. In countries like the US, Germany and the Austro-Hungarian Empire, only publications in the printed form stood in the way of a patent. The United Kingdom was the only country where a publication in any form in a different country had no effect on novelty at all. The fact that no country allowed for any period of priority if a patent had been granted elsewhere also caused complications.[62]

In 1873, these matters were brought to a head when the Austro-Hungarian Empire acted as host for the World Exposition taking place in Vienna. Many countries, especially Germany and the US, were reluctant to participate based on the poor level of protection that was offered to foreigners in the Austro-Hungarian Empire. To comply with their concerns, the Austro-Hungarian government passed a temporary law that granted protection to the inventions in the exposition. During the following ten years, meetings were held on patenting on the international scene, which resulted in the Paris Convention of 1883. Initially, there had been an attempt to create uniform patent laws in all countries, but this had proved to be an impossible task. Instead a number of general principles were adopted that left it up to each country to apply these within their own patent systems. The most important articles were number two and four. Article number two ensured that national treatment[63] should be the prevailing principle, instead of reciprocity and article four granted inventors a period of priority on patents applied for in any of the countries that were members of the convention. The Convention also agreed upon instituting the International Bureaux for the Protection of Industrial Property, which today is called the World Industrial Property Organisation (WIPO).[64]

[61] May and Sell, 2006, p. 116.
[62] Liebesny, 1972, pp. 15-16.
[63] National treatment refers to that a country should treat foreign citizens the same way as they treat there own citizens.
[64] Liebesny, 1972, pp. 16-17.

2.2.3 Patents as a business strategy

Between 1870 and 1914, the second industrial revolution took place. The leading economic and technological position shifted from England to Germany and the US. This was due to inventions in the fields of chemicals, steel, oil and electricity. These developments coincided with the transportation revolution and the creation of the telegraphy, leading to an opening up to world commerce. Large companies with ambitions to prosper on the international market evolved.[65] Two inventors in lead of this development were Thomas Edison and Werner Siemens. They introduced new ways of arranging innovative businesses through large companies with in-house research laboratories. In the US the Supreme Court's decision, United States vs. Burns, employers were given the rights to include clauses in employment contracts stating that all inventions made by an employee belong to the employer. Siemens joined the German parliament and managed to get a similar rule statutory in Germany.[66]

Edison had a business strategy where he believed market dominance could be achieved through strategic use of patents. Patents were used to uphold control over inventions by patenting extensively and applying for patents with broad claims and thereby creating barriers to entrance for other inventors. Edison also used litigation to prevent others from entering the market. Between 1885 and 1901, Edison's companies filed more than 200 infringement suits that cost the company around $2,000,000. They did not win all the lawsuits, but even when they lost, the cost of litigation for the opposite parties often forced smaller companies to close down.[67] In the judicial decision, Edison and Swan Electric Light Company v. Holland, the court had to rule in favour of Edison, but the court condemned Edison's company of "unfair exploitation of the rules of legal etiquette and avaricious patent claims" to "gain ascendancy over competitors."[68] A commentator of that time expressed concerns regarding the fact that a monopoly would keep prices high and without competition there would be no incentives to make improvements. He further argued that Edison's lamps should not be as expensive as they were. Initially, prices had to be high, but after the cost of experimenting and getting a factory in to order had been covered the prices should be significantly lowered.[69]

2.2.4 Emergence of patent cartels

Just like Edison, many German companies understood how advantageous it was to have strong patent portfolios. Germany, unified in 1871, introduced its first patent act six years later. Patent examination was strict and resulted in patents of higher quality compared to the US. Patents were granted on inventions which were new, non-obvious and with the capacity to create

[65] Sell, 2004, pp. 290-291.
[66] May and Sell, 2006, pp. 117-118.
[67] Sell, 2004, pp. 296-298.
[68] May and Sell, 2006, p. 123.
[69] Ibid, pp. 123-124.

greater efficiency.[70] It was only possible to patent processes, not products. Many German companies, especially in the chemical industry took advantage of this and successfully imitated processes invented in England.[71] German companies also took advantage of the possibility to apply for product patents in countries where it was possible. In 1912, 98% of all patents granted on chemical processes and products in the US were given to German firms. The large-scale industrial research performed in Germany in the end of the 19th century and the beginning of the 20th century made them world leading in the pharmaceutical industry.[72] This eventually led England to exclude chemical products from patentability between 1919 and 1949.[73]

Edison did not only use patents to put people out of business, he also used them to force firms into selling their businesses or agreeing on mergers. Many other firms around Europe and the US agreed on cooperative agreements based on their patent portfolios as well, some with as aggressive methods as Edison and some in more friendly manors. These agreements took the shapes of cross-licensing, price-fixing and dividing up markets. Patent cartels became very common around Europe and in the US. US statistics from 1939 show that 87% of mineral products, 60% of agricultural products, and 42% of manufactured products were sold under cartel control. Companies seemed to prefer security and control to taking competitive risks.[74] The patent climate by the end of the 19th century was, as we will see, quite similar to the patent climate at the end of the 20th century. Under the pressure of economic globalization countries adapt to the intellectual property regimes of those in leading position with the hope of improving their own economic situation.[75]

2.3 20th and 21st century

This section focuses on the dominating features of the 20th and 21st century, namely going from scepticism towards patents to strengthened patent rights.

2.3.1 Scepticism towards patents

The different cartels around Europe and the US met resistance. They became symbolic for the return of economic nationalism and World War II was a turning point. The victorious states considered economic nationalism to be coinciding with militarism and used Germany and Japan as examples. The US promoted economic liberalism, firmly relying on multilateralism. These ideals were encapsulated in the many organisations that sprung from the war; the International Monetary Fund, the World Bank, the United

[70] Khan, 2008, p. 3.
[71] Guellec and van Pottelsberghe de la Potterie, 2007, p. 32.
[72] Sell, 2004, p. 301.
[73] Guellec and van Pottelsberghe de la Potterie, 2007, p. 32.
[74] Sell, 2004, pp. 303-305.
[75] May and Sell, 2006, p.130.

Nations, The General Agreement on Trade and Tariffs and the European Economic Community.[76]

During the 1940s, anti-trust enforcement was carried out quite aggressively through laws and judicial decisions in the US.[77] The percentage of patents revoked by courts rose from 33% in 1925-1929 to more than 60% between 1940 and 1954.[78] The anti-patent climate made many firms question the economic value of patents. Some firms started to rely on trade secret as protection for their inventions, but it was not suitable for all kinds of products and processes. In the consumer electronic industry, for example, few firms dared to commercialize their products when the financial risks were so high. Even if inventions like the transistor and the video cassette recorder were American inventions, other countries, notably Japan, commercialized these products.[79]

2.3.2 Resurgence of patents in the US

By the late 1970s and the early 1980s, changes in the political agenda asserted the importance of patents to maintain an innovative society. The courts, which had had a restrictive attitude towards patents, also began to show a more positive attitude towards patents.[80] In the case Dawson Chem. Co. V. Rohm and Haas Co. the Supreme Court declared that "the policy of free competition runs deep in our law... but the policy of stimulating invention that underlies the entire patent system runs no less deep."[81] This was the first time since the beginning of the 20th century that free competition and patent rights were considered equally important. According to May and Sell it would not take long until the rights of patent owners would become more important than supporting free competition to the US government[82].

In the early 1980s, President Carter's administration began to feel threatened by the growing Japanese economy. As a countermeasure they presented the "Domestic Policy Review of Industrial Innovation". To overcome the competitive challenges the US society was facing, a stronger patent system was suggested as part of a solution. The most important proposed feature of the patent system was a new centralized appellate court for patent cases. Previously, patent cases had been appealed in various circuit courts around the country. The application of patent law had been very uneven in the different courts. It was almost six times more likely that a patent would be upheld in the Tenth Circuit as in the Second Circuit in the years 1953 to 1977.[83] This caused parties to go "forum shopping" and request transfer of their cases to different circuits.[84] The differences in

[76] Sell, 2004, pp. 305-307.
[77] Ibid, p. 307.
[78] Guellec and van Pottelsberghe de la Potterie, 2007, p. 30.
[79] May and Sell, 2006, p. 140.
[80] Ibid, p. 141.
[81] Kastriner, 1991, p. 20.
[82] May and Sell, 2006, p. 141
[83] Jaffe and Lerner, 2007, pp. 100-101.
[84] May and Sell, 2006, p. 142.

rulings were upheld by the fact that the Supreme Court rarely tried patent cases and consequently, precedents that the circuits could fall back on were created infrequently. The Court of Appeals for the Federal Circuit (CAFC) was finally established in 1982.[85]

The CAFC caused significant changes in the U.S patent climate. During the first eight years of its operation, the CAFC affirmed infringement in 90% of the cases they tried. The corresponding percentage for the circuit courts had been 62%. In cases where the district courts, on the contrary, had found a patent to be invalid or not infringing, the circuit courts had reversed only 12% of these cases. During their first eight years, the CAFC reversal rate was 28%. The pro-patent attitude of the CAFC encouraged patent holders to file for infringement. This led firms to file opportunistic infringement lawsuits; lawsuits which never would have been initiated under the old appeal system. Many of these cases were too dubious even for the pro-patent court and the overall percentage on cases won by patent holders were brought down. The pro-patent stance of the CAFC also affected the district courts. Before the CAFC was established, 30% of all patents tried in the district courts were considered valid and infringed upon. The corresponding percentage the year of the establishment of the CAFC was over 55% and rose to over 65% by the end of the 1990s. The rulings of CAFC has strengthened the presumption of validity of patents and lowered the level of creativity required to receive a patent.[86]

The CAFC has also strengthened the remedies in patent cases. In infringement cases, the patent holder can request damages and an injunction. Damages are remedies for past infringement and injunctions forbid the defendant from continuing to infringe in the future. Most dramatic has the use of preliminary injunctions been. These can be issued before trial in exceptional cases to prevent irrevocable harm. Before the establishing of the CAFC, preliminary injunctions had not been used in patent cases. Shutting down the defendants business before the plaintiff's patent even has been proven valid in court is a far-reaching measure. Even though preliminary injunctions are not used very often, they have added significant power to patent holders which they can benefit from during settlement negotiations.[87] The establishing of a centralized IP court in Europe depends greatly on whether the Community Patent project discussed below is realized.[88]

2.3.3 Increased patenting activity

During the last two decades there has been a rapid growth in patenting activity. The statistics in the introduction to the thesis showed increases with 150% and 200% at the EPO and USPTO. What factors have contributed to this growth? Extension in patentable subject matter, broader patents –

[85] Jaffe and Lerner, 2007, p. 99.
[86] Ibid, pp. 104-107.
[87] Ibid, pp. 110-111.
[88] Martinez and Guellec, 2004, p. 10.

especially in new areas, increased flexibility and lowered costs of patent filings, and higher rates of patent validation in court. These changes have been spurred on for several reasons. First of all, a greater belief among policy makers that patents are closely linked to innovation and economic growth.[89] The director of USPTO referred to the increase of patent applications as "a boom for America's economy, as well as contributing to our genius for innovation."[90] Secondly, many decisions on future development of patents are taken by new governing bodies like WTO, WIPO, major patent offices and specialized courts like the CAFC. Thirdly, patent systems in different countries are becoming increasingly harmonized.[91] These international governing bodies and the increased harmonization are discussed further under section 3.3.5.

The extension of patentable subject matter occurred during the 1980s and 1990s. In the US, a number of court rulings paved the way. In the case Diamond v. Chakrabarty, the Supreme Court declared that "anything under the sun made by man" is patentable and made utility the standard of patentability instead of technicality. This case made it possible to patent genetic material, Diamond v. Diehr and Re Alappat made it possible to patent software, and State Street Bank & Trust Co. v. Signature Financial Group, Inc. made it possible to patent business methods. In Europe, patentable subject matter has also been extended. Genetic material and software related inventions were made patentable after decisions by the board of appeal of the EPO, but not business methods.[92] An invention must be of "technical character" to be patentable at the EPO.[93]

2.3.3.1 Increased workload at the patent offices

The increase in patent applications has dramatically raised the workload of the patent offices. It is not only the number of patents that have increased the workload, but the average number of claims and the average number of pages in the patent applications. The average number of claims and pages in applications at the EPO has almost doubled since the 1980s, from 12 to 20 respectively 16 to 30. It is estimated that the workload of the EPO is 20 times higher today than 25 year ago. The increase in workload raises questions on quality issues both concerning the EPO and the patent system in general. Many patent applications involve only minor improvements compared to the prior art. There is a risk that patents are granted on products, which are neither new nor fulfil the inventive step because it has become too difficult to survey the increased amount of prior art. The EPO is experiencing a growing backlog of applications, which creates uncertainty for both applicants and their competitors.[94] The average time before a decision is presented to the applicant is about four years.[95] The only way to

[89] Martinez and Guellec, 2004, pp. 2-3.
[90] Ibid, p. 4
[91] Ibid, pp. 7-9.
[92] Guellec and van Pottelsberghe de la Potterie, 2007, pp. 119-126.
[93] Martinez and Guellec, 2004, p. 11.
[94] Guellec and van Pottelsberghe de la Potterie, 2007, p. 211.
[95] Ibid, p. 201.

deal with the backlog is to spend less time on each application and put quantity ahead of quality. Guellec and van Pottelsberghe experiences that lowered patent standards have already become a reality. This has created a vicious cycle where more applicants take a chance with inventions of low quality, which in turn increases the workload even more. When small improvements receive patents others are inclined to patent their small improvements as well before someone else does it. Today patent examiners at the EPO refuse about 5% of the applications, but the figure would be higher if it is taken into consideration that about one sixth of all applications are withdrawn due to communication with the examiner.[96] The EPO recently released statistics for 2007 and it seems as they have started to break the vicious cycle. The statistics show that the number of patent applications has continued to increase, but that the granting rate has decreased compared to 2006. Allison Brimelowe, the President of the EPO, explains that a high number of patents do not necessarily indicate that more resources are spend at R&D. She also declared that the EPO is emphasizing quality over quantity.[97]

The USPTO is experiencing similar problems. The number of patent applications an examiner has to review per year has increased steadily. The average time of the examination process is three years. During those three years an examiner spends 18 hours on average "reading the application, searching for and reading prior art, comparing the prior art to the application, writing one or more provisional rejections, reviewing responses and amendments, often conducting an interview with the applicant's attorney and writing a notice of allowance."[98] In spite of the short time spent on each application, statistics from 2007 show that they have a backlog of 1,112,000 applications.[99] These circumstances, just like at the EPO, increase the number of patents of questionable quality and add to the vicious cycle described above.[100] Compared to the EPO, the USPTO have a much lower number of examiners. In 2007, the USPTO received three times as many patent applications as the EPO.[101] The USPTO had 5,400 patent examiners and the EPO had 4000.[102]

In the early 1990s, Congress made the USPTO a self sufficient agency. Instead of being financed by tax money it was to be financed by application fees. This has had significant impact on the development of the USPTO. How much employees receive in bonus and future promotions are based on how productive they are. Productivity is measured in points. Examiners

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[96] Guellec and van Pottelsberghe de la Potterie, 2007, p. 211 and pp. 217-218.
[97] See http://www.epo.org/topics/news/2008/20080401.html
[98] Lemley and Shaprio, 2005, p. 79.
[99] See http://www.uspto.gov/web/offices/com/annual/2007/50303_table3.html
[100] Lemley and Shapiro, 2005, p. 79.
[101] A comparison between statistics available at the following pages:
http://www.uspto.gov/web/offices/com/annual/2007/50302_table2.html
http://documents.epo.org/projects/babylon/eponet.nsf/0/8F1AA130988B162DC125741E005BC644/$File/Annex_080401_en.pdf
[102] See http://www.uspto.gov/web/offices/com/annual/2007/50328_table28.html
and Guellec and van Pottelsberghe de la Potterie, 2007, p. 28.

receive one point when they complete an initial review of a patent application and a second point when they present a decision to allow or refuse the application. If a patent examiner rejects a patent application the applicant might modify the patent application or appeal the decision. This delays the dealing out of the second point. A refused application generally take up more time for the patent examiner and clearly, the incentives for allowing patents to be granted is much higher.[103] The PTO Business Plan of 2000 stated that "The Patent Business is one of the PTO's three core businesses. The primary mission of the Patent Business is to help customers get patents."[104] The PTO was criticized for this statement and changed their objectives with the Business Plan of 2002 and stressed enhanced quality of their products and shorter processing times.[105] In 2004, 85% of all patent applications filed resulted in issued patents.[106]

The USPTO have had great difficulties in recruiting and retaining the best examiners since they cannot compete with salaries offered by IP law firms. In 2001, 55% of the staff had worked less than 2 years at the USPTO. Inexperience in combination with the improper incentive system and the short amount of time the examiners have to spend on each application is especially troubling when it comes to the newer patentable subject matter. Much of the prior art in these field come in non-patent forms, which take much longer time to find and examine.[107]

2.3.4 European harmonization

The discussions on integration of European patent systems have followed in the steps of integration of Europe in general. As early as 1949, the Council of Europe argued in favour of creating a European Patent Office. The interest in an integrated patent system was due to the aspiration of creating an integrated market. The members of EC agreed upon a couple of regulations regarding patents in 1963, but the greatest breakthrough came in 1973 when the European Patent Convention (EPC) was signed. It entered into force in 1977 and today it applies to 34 countries.[108] The EPC contained an agreement to set up a European patent Office (EPO). The EPO examines applications and grants patents which become valid in the EPC member countries the patentee has chosen. The patent has to be translated into the languages of the countries where the patentee wants to have a patent. It is up to the courts of every country to determine the validity of a patent if it is questioned. The EPC is generally considered a success. Harmonization has led to the strengthening of patent systems in Europe. Many countries had incomplete patent systems, but have now been forced to measure up to the standards in EPC. The EPC has also involved a lowering

[103] Jaffe and Lerner, 2007, p. 4 and pp. 136-137.
[104] USPTO, PTO Business Plan: February 2002, p. 12. Quote found in Jaffe and Lerner, 2007, p. 137.
[105] Jaffe and Lerner, 2007, p. 137.
[106] Lemley and Shapiro, 2005, p. 79.
[107] Jaffe and Lerner, 2007, p. 145.
[108] http://www.epo.org/about-us/epo/member-states.html

of costs for receiving patent protection Europe-wide. Even if it is expensive to apply for a patent at the EPO, it is much cheaper than applying at every domestic patent office around Europe.[109]

The EPO does not have any connection with other organizations on EU-level. Integration on EU level with a truly European patent has not yet become a reality. A community patent has been discussed since the 1960s and an agreement came very close in 2004. The matter that has been the most difficult to agree upon is translation issues. Some EU-members are concerned about time delays caused by translation of patents and what would happen if there are translation errors in a patent document. "What language would be the reference of the courts?"[110]

2.3.5 Global harmonization

The international intellectual property arena in the post-World War II era was significantly altered when many of the European colonies became independent states. While developed countries pushed for strengthened patent rights, the developing countries pursued their own interests and raised demands on changes in the Paris Convention that would take into consideration their economic and social conditions. This was the beginning of what is called the North and South conflict. It proved to be impossible to implement changes in the Paris Convention due to diverging opinions and the large number of already existing member states.[111] After unsuccessful negotiations within WIPO, parties started negotiations under the General Agreement on Trade and Tariffs (GATT). GATT was more advantageous for the developed countries for two reasons. Firstly, they had a stronger bargaining position in the GATT-forum compared to the "one country one vote" system within WIPO where the developing countries were dominating. Secondly, GATT offered a possibility to negotiate cross-sectorially on both intellectual property and trade-related issues.[112]

Among the developed countries, it was the US that most actively pursued a new multilateral settlement. Their pursuit intensified after the private sector emphasized the importance global IPRs to maintaining a leading economic position. In the 1980s, a group of US corporations established the International Property Committee (IPC). This committee brought pressure on the US government to negotiate the future design of global IPRs, as well as supported the government's negotiating team in legal matters. The IPC also worked with representatives from European and Japanese industrial associations in order to convince them to support their pursuit for a new international IP-regime. Together they eventually presented a document to the GATT secretariat, which greatly influenced the TRIPS agreement.[113]

[109] Guellec and van Pottelsberghe de la Potterie, 2007, pp. 27-29.
[110] Guellec and van Pottelsberghe de la Potterie, 2007, pp. 27-29.
[111] Rosén, 2005, p. 5.
[112] Yu, 2005, p. 357.
[113] May and Sell, 2006, pp. 153-154

The US Trade Representative (USTR), acted to convince those opposing the ideas of the US in the TRIPS negotiating group and to speed up the negotiating cycle. Under the Special 301 section of the Omnibus Trade and Tariff Act of 1988, the USTR threatened with and used bilateral trade sanctions to promote their cause.[114] These actions were mostly directed towards the developing countries whose governments had most actively opposed the US' ideas, for instance, Argentina, Brazil, India, and South Korea.[115] The USTR also used encouragement in the form of promises to open up agricultural markets and to put an end to the Multi-Fibre Arrangement, which had restricted developing countries' textile exports. In addition, the USTR made bilateral agreements with developing countries containing provisions similar to what they wanted to see in the TRIPS agreement so that the step to accepting TRIPS eventually would not be so far away for developing countries.[116] The negotiations reached a deadlock in the early 1990s, and the GATT secretariat and the Chairman presented a "take it or leave it" draft with provisions that they considered acceptable to both sides. The draft was accepted after only minor changes had been made and entered into force in 1994.[117] A document signed prior to the TRIPS negotiations shows that the developing countries only agreed to negotiate on IPRs to a limited extent. The final agreement turned out to be much more detailed than the developing countries had expected.[118]

During the time of the TRIPS negotiations, many of the developing countries had limited knowledge about intellectual property protection. The United Nations Development Programme declared in 1999 that agreements on intellectual property were signed "before most governments and people understood the social and economic implications of patents on life. They were also negotiated with far too little participation from many developing countries now feeling the impact of their conditions."[119]

TRIPS is the most important modern descendant of the Paris Convention. The World Trade Organization (WTO) replaced GATT as an international organization, but GATT is still a general treaty for trade in goods. Today WTO has more than 150 members[120] and to gain membership a country must accept the TRIPS agreement.[121] The preamble to the agreement states that WTO-members are "Desiring to reduce distortions and impediments to international trade, and taking into account the need to promote effective and adequate protection of intellectual property rights, and to ensure that measures and procedures to enforce intellectual property rights do not themselves become barriers to legitimate trade."[122] Another section in the preamble states: "Recognizing also the special needs of the least-developed

[114] May and Sell, 2006, p. 153-154.
[115] Yu, 2005, p. 413.
[116] May and Sell, 2006, pp. 154-155.
[117] Ibid. p. 362.
[118] Seth, 2004, p. 306.
[119] Yu, 2005, pp. 359-360.
[120] See http://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm
[121] Scotchmer, 2004, p. 321.
[122] See Preamble TRIPS.

country Members in respect of maximum flexibility in the domestic implementation of laws and regulations in order to enable them to create a sound and viable technological base."[123] At a first glance, this paragraph seems to take into account the special circumstances of developing countries, but the flexibility only refers to the implementation and not to the obligations themselves.[124]

TRIPS presents a number of minimum standards that the member states have to comply with. Just like the Paris Convention, TRIPS rely upon the principle of national treatment.[125] The more patent specific regulations state that patents should be available for all fields of technology for both products and processes, if they are new, involve an inventive step and are capable of industrial application. States *may* exempt diagnostic, therapeutic, and surgical methods as well as plants and animals and the biological processes for producing them.[126] The duration of protection is 20 years.[127] TRIPS also has a mandatory dispute settlement procedure.[128] If a country does not follow the minimum standards set by TRIPS, it faces the risk of retaliation in terms of trade restrictions.[129]

It should be mentioned that harmonization efforts also have intensified at WIPO. In 2000, the Patent Law Treaty on patent application procedures was signed and there are ongoing discussions on the provisions in a Substantive Patent Law Treaty aiming at, for example, harmonizing the criteria for patentability for example.[130]

2.3.5.1 Some issues of concern for developing countries

This section covers some of the most troubling issues developing countries are faced with after signing the TRIPS agreement. First of all, it should be mentioned that developed countries failed in fulfilling the promises of reduced trade tariffs and lowered subsidies on agricultural and textile products.

2.3.5.1.1 Structural changes and time frame

For most developed countries, the TRIPS agreement does not involve so many changes. National legislations of the developed countries already contain the minimum standards set by TRIPS. In contrast, most developing nations have to carry through large transformations. Many of these nations only have laws that to a very limited extent correspond to the provisions in TRIPS. Each country is obliged to establish authorities that will monitor the observance of the laws. They will also have to educate more lawyers and

[123] See Preamble TRIPS.
[124] Correa, 2007, p.13.
[125] Art. 3.
[126] Art. 27.
[127] Art. 33.
[128] Art. 63 and onwards.
[129] Verspagen, 2003, p. 506.
[130] Martinez and Guellec, 2004, p. 8.

engineers to cope with complicated patent applications. Both education and establishment of the monitoring authorities will be very costly for the developing countries.[131] According to Article 67, developed countries should give financial and technical support to make the implementation of TRIPS easier.[132] The transitional period for developing countries was set to 2000 and 2005 for the least developed countries (LDC). Introduction of patent laws on pharmaceuticals in the LDC countries was extended to 2016 as late as 2001.[133] Notwithstanding, these are much shorter time frames than developed countries had to reach today's patent standards. Most developing countries became independent as late as the mid-1900s and they adopted patent policies a century after developing countries adopted theirs.[134]

2.3.5.1.2 Access to drugs

Another issue of concern for developing countries is the fact that TRIPS secures patent protection in fields where it has not been possible to receive a patent before. Developing countries have previously been able to copy other's inventions in the absence of domestic patent protection. Companies that previously have copied other's inventions and cannot afford licensing fees will have to shut down. Their products will be replaced by imported products, which are most likely more expensive.[135] This would also lead to increased unemployment rates.[136] Many authors argue that TRIPS foreclose developing countries from a course of action once used by developed countries to build their economies. We are "kicking away the ladder" that developed countries once have climbed to reach the top, as Chang has expressed it.[137]

The rate of production and access to pharmaceuticals in developed countries compared to developing countries shows a great gap. Pharmaceutical companies in developed countries are responsible for more than 80% of all pharmaceutical sales in the world. The costs of putting forward a new drug are great.[138] Only one out of five attempts to develop a new drug succeeds. A successful drug must therefore result in revenues equal to five successful drugs to cover the costs. According to PhRMA, the trade organisation of the U.S pharmaceutical firms, only 30% of all drugs put on the market recover such profits.[139] Most of the pharmaceutical companies' production and research target diseases of developed countries since that is where the largest profits can be made. Only about 5% of all pharmaceutical research is performed on diseases primarily afflicting people in developing countries.[140]

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[131] Seth, 2004, p. 343.
[132] Art. 67.
[133] Seth, 2004, p. 323.
[134] Ragavan, 2003, pp. 149-150.
[135] Seth, 2004, p. 343.
[136] Ragavan, 2003, p. 169.
[137] Chang, Ha-Joon., The title of his book on development strategies in a historical perspective.
[138] Seth, 2004, pp. 335-336.
[139] Scotchmer, 2004, p. 116.
[140] Seth, 2004, pp. 335-336.

In some of the larger developing countries like Brazil, China and India there are local pharmaceutical companies, which mainly produce generic drugs. These drugs are copies of drugs produced by pharmaceutical companies in developed countries and therefore cost much less to produce. Before TRIPS it was possible to produce generic drugs in countries where pharmaceuticals were not protected by patent laws. Today it is only allowed to produce patented drugs in countries that fall under the pharmaceutical exemption lasting until 2016, mentioned above, or if the patent has run out, or the generic drug company has a licence that gives them that right, or if a compulsory license has been granted. A compulsory license can be granted "...in the case of a national emergency or other circumstances of urgency..."[141] The Doha Declaration on the TRIPS Agreement and Public Health in 2001 states that "each Member has the right to determine what constitutes a national emergency or other circumstances of extreme urgency, it being understood that public health crisis, including those relating to HIV/AIDS, tuberculosis, malaria and other epidemics, can represent a national emergency or other circumstances of extreme urgency."[142] The compulsory license provision has rarely been used but has proven to be a good a bargaining weapon. In 2001 Brazil's economy was pushed to the limit when the costs for a single antiretroviral drug mounted to $303 million per year. Brazil requested that Roche, the producer of the drug, reduced the price significantly, but Roche refused to lower the costs with more than 30%. Brazil responded by openly deprecating patents on drugs and threatened to grant a compulsory license. In the following negotiations, Roche agreed to lower the costs with 70% to avoid a compulsory license.[143]

Even developed countries have considered various measures to limit the rights of patent holders when facing an economic or public health crisis. Between October and November 2001, the U.S reported of 10 anthrax cases. As the fear of bioterrorism grew, both the U.S and Canadian governments took significant measures to reduce the price on Cipro, the anthrax drug. Public health was given a higher priority than business interest.[144] Bayer AG, the owner of the patent on Cipro, eventually agreed to lower its price from $1.77 to 95 cents.[145] The number of anthrax cases eventually rose to about 60, which is a very modest figure compared to the percentages of populations in developing countries that are infected with serious diseases.[146] According to Ragavan "...developed nations lack an understanding of the fact that developing countries cannot sacrifice their ailing millions for fear of trade sanctions."[147]

[141] Art. 31.
[142] Doha Declaration, P 5(c)
[143] Ragavan, 2003, p. 174-175.
[144] Ibid, pp. 166-167.
[145] Pugatch, 2004, p. 218.
[146] Ragavan, 2003, pp. 166-167.
[147] Ibid. p. 179.

2.3.5.1.3 Technology transfer

It was thought that by increasing the standards of IPRs in developing countries world trade would be promoted and lead to economic development. Is there any proof of the correlation between intellectual property laws and higher volumes of international technology transfer to developing countries? The effects of technology transfer (TT) can be divided into direct and indirect effect. Direct effect refers to the extent that foreigners, in return for IPRs, have to make technology available in developing countries. Indirect effect refers to how a an improved environment for IPRs increases companies' interests in TT in the form of licensing agreements, joint ventures and foreign direct investment (FDI) in developing countries.[148]

We begin by considering the direct effects. A patentee is required to disclose his invention. It is argued that the disclosure makes it possible for developing countries to access new technology and can use this knowledge as a basis for further research or to copy the product after the patent expires. In practice, the disclosure in developing countries is of less relevance. A firm who intends to patent a product in a developing country has most likely already patented the product in his home country. A firm in a developing country, who wishes to find information on the product, only has to turn to the patent office of the patentees' home country. Many developing countries have proved with their pirated goods that they do not need any disclosed information at all to produce copies or similar products. Regarding accessibility, a patent does not require a patentee to work his patent in the country where he has received a patent. These patents prevent others from using or commercializing the product. The number of non-worked patents in both developed and developing countries are high, but higher in the later.[149]

Now let us consider the indirect effects of TT. It sounds reasonable that stronger IPRs protection in developing countries would increase the interest in TT to developing countries, but there is little empirical data to confirm it. It is problematic to assemble data that isolates the effect stronger IPRs have on firm's willingness to invest in developing countries from all the other factors that are of importance to a firm's decision.[150] Lee and Mansfield, who studied the importance of IPRs to FDI for 100 US firms, found that the importance of IPRs varies depending on the kind of investment. He identifies five types FDI: sales and distribution outlets, rudimentary production and assembly facilities, facilities to manufacture components, facilities to manufacture complete products and R&D facilities. The higher level of investment, the more important are IPRs. Regarding investments in sales and distribution outlets only 20% of the survey participants found IPRs to be important. The corresponding percentage for investments in R&D facilities was 80%.[151] Other surveys come to different results. Maskus and Konan concluded that the physical presence or investment of US firms in

[148] Pugatch, 2004, p. 57.
[149] Ibid. pp. 57-60.
[150] Ibid. p. 63.
[151] Lee and Mansfield, 1996, pp. 181-186.

developing countries has little to do with the level of intellectual property protection. Schuman, who performed research on the levels of investment and IPRs in South East Asia, found that during the 1980s the granting of foreign licenses in South Korea was very common even though the levels of IPRs were low. South Korea was at the time one of the countries under threat of Special 301. Schuman could not find a causal link between stronger IPRs and TT.[152]

2.3.5.1.4 Domestic innovation

Would stronger IPRs in developing countries increase the level of domestic innovation? Kang and Seo found that stronger IPRs alone do not increase the rate of innovation, which was measured in the number of patents. Boosts in innovation are related to other complementary factors such as "the stage of economic development, industrial structure, trade regime and institutional environment".[153] Only countries with a gross domestic product (GDP) per capita above $9,000[154] gained, in terms of innovation, from strengthening of IPRs. Kang and Seo conclude that "technological change is a complex and non-linear process, which requires the fine-tuning of policy coordination across diverse areas, rather than a linear process in which the strengthening of IPRs in isolation automatically stimulates innovative activity".[155]

Lerner performed a study where he looked at significant changes in patent regimes in 70 countries over 150 years. Just like Kang and Seo, he meausered the rate of innovation by the number of patents granted. He found that a majority of the changes increased patent protection and concluded that strengthening of patent protection had a negative effect on patenting by nationals in countries that already had a high standard of protection and in countries with weaker protection and a low GDP per capita.[156]

2.3.5.1.5 TRIPS-Plus agreements

In recent years it has become common for the US and the European Union to use bilateral, and sometimes multilateral, agreements that go beyond the TRIPS agreement. This is a way to improve their own bargaining positions as well as responding to demands of diversification raised by developing countries. The US had by the end of 2004 successfully negotiated free trade agreements with about 15 developing countries. Bilateral agreements can take into consideration special circumstances of the contracting parties. Most often they led to greater changes than multilateral agreements. In return for improved trade conditions developing countries agree to introduce stronger intellectual property rights. In general, improving trade condition is

[152] Pugatch, 2004, p. 63.
[153] Kang and Seo, 2006, p. 139.
[154] GDP per capita differs greatly in developing countries. In the International Monetary Fund's World Economic Outlook database from 2007, the country with the lowest GDP per capita is Liberia ($18) and the highest is Luxembourg ($87400). Newly industrialized countries such as Brazil, China, India and Mexico have the following corresponding figures: $10637, $8788, $4183 and $11880.
[155] Kang and Seo, 2006, p. 139.
[156] Lerner, 2002, pp. 1-2 and 17.

the first priority for developing countries and they therefore accept these kinds of agreements even though stronger intellectual property rights are not beneficial to them. [157]

2.4 Analysis

Even though patent protection, most likely, never has been as strong as it is today, the progression towards stronger patent rights has been contested throughout history. The evolution of patents has been far from linear. The design of patent systems, of different times and countries, are products of the environment in which they operate. Patent history follows in the steps of much of the general evolution of society. Patents have not been designed nor worked in isolation of historical crosscurrents and events. They have been more popular and less popular, strengthened and weakened, much in accordance with general developments in society. The purpose of this chapter has been to highlight historical trends in the evolution of patents. This analysis aim at turning these trends into general patterns and provide a useful base of knowledge for future changes of the patent systems.

2.4.1 Shift of power

Since the 19th century, the position of private actors compared to kings and governments has been significantly strengthened in regards of patents. In early patent history, patents were privileges granted by the ruler and at least the English granting process was very arbitrary. With growing mercantilism and ideas of natural rights, the private actors gained more power. The interests of businesses have been increasingly prioritized by governments since the success of countries depends to a large extent on how prosperous domestic businesses are. Private actors have also been more engaged in the design of patent laws to make them more respondent to their needs. One of the earlier examples is Siemens, who joined the German Parliament in the end of the 19th century and a more recent example is the IPC's involvement in the TRIPS agreement. Just as kings and governments have been loosing power to private actors, they are also loosing power to multilateralism. The space for patent laws of the nation state has shrunk significantly over the years.

2.4.2 Technological progress

The advancement of science and the introduction of new technologies have had a great impact on the evolution of patents. Technological progress has been accompanied by increased patenting and in more recent years stronger patent rights. These trends were apparent during the first and second industrial revolution as well as in more recent technological progress in information technology and biotechnology. Even though patent systems in most countries have gone through significant changes and become more efficient since the first industrial revolution, some similar problems that

[157] Yu, 2005, pp. 392-400.

existed then are still present today. For example the fact that many patent holders cannot be sure of their patents' value until they have been tried in court. During the industrial revolution the uncertainty in value was due to that patents were issued without any examination of novelty. Today patents have to pass a novelty examination, the problem is rather caused by the fact that many patents are too obvious in comparison to prior art.

2.4.3 From single inventors to R&D laboratories

Looking back in history, the development has gone from single inventors to R&D laboratories. These kinds of laboratories began with Edison and Siemens, who both managed to create successful companies this way. They were able to keep the inventions invented by their employees since both the US and Germany introduced laws making it possible for an employer to include clauses in employment contracts giving the employer the right to inventions made by an employee. Edison was a true business man and was the first person to use patents as business strategies. Chapter 4 will show that the strategic use of patents is still important for many firms today.

2.4.4 Changes in the popularity of patents

Patents, as an institution, have been seriously contested twice throughout history. Are there any patterns on why these contestations occur? The patent controversy between 1850 and 1875 was mainly due to ideas that the patent system did not work well as an incentive mechanism. The scepticism towards patents, which rose during the mid 1800s, was a reaction to the growing number of cartels in Europe and the US, triggered by the fear of economic nationalism. In general, anti-patent movements have occurred when patent systems work poorly. At the turn of the 19th century, inventors found patent systems in continental European countries costly and the administrative system complicated. In addition, mere registration procedures, in countries like England and France, instead of novelty examinations must have resulted in an uneven distribution of rewards. About the English patent system it should be said that it was probably not equipped to handle the increase of inventions and innovations during the industrial revolution. In the prelude to the second anti-patent era the strategic use of patents had increased and patent systems were contributing to the abusive behaviour of patent cartels, which was causing discontent. Today's patent systems are under heavy critic and there are already discussions on whether we are entering a new anti-patent era. There is a substantial amount of proof that today's patent systems have features that work poorly, which in turn might very well lead to a third anti-patent era.

When are patents strengthened? What inspires pro-patent eras? Periods of patent contestation seem to be followed by strengthened patent rights. The patent controversy beginning in the 1850s was followed by the Paris Convention and the introduction of patent protection in countries opposing patents, like the Netherlands and Switzerland. The anti-patent era during the 1900s was followed by European harmonization and pro-patent policies in

the US. Whether there is cycle of contestation and strengthening of patent rights is too soon to say, but it will certainly be of interest to see what direction the current pro-patent era takes.

2.4.5 Private rewards in favour of public access

Since the latest contestation of patents, rewards to the inventor seem to have been given higher priority than public access. From a historical perspective, many of the earlier patent laws or practices, in spite of their incompleteness at large, held requirements that a patent could be revoked if they caused inconvenience to society. Consider for example the early practice with patent privileges in Venice. These privileges could be revoked if they were of socioeconomic importance to the state. The Statute of Monopolies held similar requirements. Provisions in today's patent laws with the closest resemblance to these examples are the articles on compulsory licensing in the TRIPS agreement. We know little of how often the ability to revoke patents was used in Venice and England, but we do know that the articles on compulsory licensing in TRIPS rarely have been used even though there seems to be several reasons.

2.4.6 Increased harmonization

Harmonization of patent laws and international cooperation has followed in the steps of market change, from domestic to European and to world markets. Since the end of the 19th century harmonization has been an on-going process dominated by those in market leading positions. To be fully accepted as a participant on the international market, harmonization has been of utter importance. Harmonization has to a great extent been driven by the interest of inventors to protect their works outside their home country. One difference between the three stages of harmonization described in this thesis - The Paris Convention, EPC and TRIPS - is that the first two to be agreed upon was between parties with much more equal levels of economic development. In addition to the diverging strengths of the different parties during the negotiations of TRIPS, it was agreed upon in the midst of a pro-patent era. These two factors have had significant impact on the establishment and design of this agreement.

2.4.7 Conditions for industrial development

Looking back in the history of patents, weak patent protection has been a deliberate choice in many countries to promote industrial development. In the US, foreigners were in the first 40 years of the patent systems existence not able to patent their inventions. The American citizens were not allowed to patent foreign inventions either since inventions had to be truly novel. American citizens could instead use foreign inventions freely. In France patents were granted on foreign inventions, but French citizens were not allowed to patent their inventions in other countries. The choice by the Netherlands to revoke its patent law and the choice by Switzerland to not have a patent law was also based on the interest in being able to use foreign

and domestic inventions freely. In the late 1800s, Germany benefited from the fact that processes could not be patented in Germany and freely copied processes used in England. Eventually Germany became world leading in pharmaceuticals. The various measures taken by these different countries were all part of strategies to promote industrial development in their own country.

The level of development in these countries at that stage in history can be compared to the stage where many of the today's developing countries are today. Many of the developing countries gained their independence after World War II and they are not given the same time as developed countries had to experiment with various standards for patentability. So is this enough to refrain from extending patent harmonization to developing countries? Taking into account the various concerns presented in section 2.3.5.2, it is clear that it is the developed countries that are making the greatest gains. The globalisation of patents has failed to balance how companies can secure returns from their innovation with public welfare. This particular subject is discussed further in the analysis in chapter 5. The historical development of developed countries suggests that we should allow the introduction of patents to take longer time in developing countries.

2.4.8 Where to go from here?

The increased patenting activity we have experienced since the 1980s have been accompanied by a greater interest to protect innovations. On the international scene, the liberalization of trade has brought about a stronger interest in protecting private assets. TRIPS is a proof of this. Increased protection has been followed by reduced competition and diffusion. As a conclusion, it could be said that patents have always been and will always be instruments to create financial gains for a country and an inventor, but taking into account the recent developments with increased patenting activity, strengthened patents, and global harmonization taking place at a rapid pace, it becomes obvious that the patent systems cannot continue in this direction indefinitely without stifling future innovation. The problems at the patent offices have to be addressed to break the vicious cycle with an increasing number of low-quality patents. Chapter 4, emphasizes the importance of finding a balance between rewards to inventors and facilitating for future innovation which encourages economic growth, but firstly some basic concepts of economics relevant for this discussion is presented in the following chapter.

3 Law and economics

The perspective of law and economics is used to evaluate the role of law in the public economy. Since the 1960s, the use of the law and economics approach has increased consistently. Out of all interdisciplinary methodologies, this is the one most frequently found among articles in American law reviews. In Europe, the economics of law is debated, but not as heavily as in the US. [158] The following paragraphs highlight some of the basic concepts in economics relevant to the following discussions in chapter 5.

3.1 Rational choice and maximization

Consumers and companies make choices based on the knowledge that resources in society are limited. Let us begin by studying more closely how consumers make their choices. The theory called *the economic man* presumes that people, besides making choices based on the limitedness of resources, are making rational choices which maximize their utility. The preferences of the consumer are subjective. Their choices are results of complete, transitive and reflexive evaluations. This means that a consumer has been able to compare all goods and services and rank them according to their utility for him, value the utility consequently and have transitive preferences[159]. A consumer who does not hold these characteristics is not considered rational. Time, energy, knowledge, or the consumer's income can also hinder the consumer from making the choice which maximizes his utility the most. The consumer's optimum, which gives a consumer the greatest utility, is found by combining her preferences with her income and indifferences.[160] How do companies make their choices? They make choices based on how they can maximize their profits. Profits are the difference between the total revenue and the total cost of production.[161]

3.2 Market equilibrium and efficiency

How do the utility-maximizing individuals and the profit-maximizing producers interact on the market? Price and quantity are determined by the reciprocal action between supply and demand. If a price is lowered consumers are interested in buying more and if a price goes up consumers will buy less. This is called *the law of demand*. Not all utilities are equally sensitive to changes in price. In addition, some utilities are more important to consumers since certain needs have to be satisfied. Food is, for example, considered more important than swimming pools. Price and quantity are also affected by the occurrence of similar utilities on the market. If the price

[158] Cooter and Ulen, 2000, p. 2.
[159] Transitivity could be explained with the following example: if an individual prefers A to B and B to C, then she must prefer A to C as well.
[160] Cooter and Ulen, 2000, pp. 16-18.
[161] Dahlman et al., 2004, p. 38.

goes up, a consumer might buy the cheaper substitute. The rational consumer wants to maximize the utility. Since she is limited by her income, the optimal choice is thus affected by price changes on the market.[162]

Market equilibrium, at perfect competition, occurs when the demand of the consumers equals the quantity that companies are willing to supply. An industry is considered perfectly competitive when there are so many companies that a decision by one of them does not influence the market price and there are so many customers that an individual decision does not affect the market price. When all markets experience equilibrium it is called a general equilibrium.[163] Why is market equilibrium considered ideally? It has to do with efficiency and the following paragraphs explain how.

There are two basic efficiency theorems in economics. The first one is called *the Pareto efficiency criteria*. According to this theorem, a certain situation is pareto efficient if it is not possible to change it for the better for one person without making it worse for someone else. Whether a situation becomes better or worse is based on the individuals own estimation. The other theorem, *the Kaldor-Hicks efficiency criteria*, suggest that efficiency is reached if an individual or some individuals become better off than those who get it worse. Or in other words, gainers should gain more than the losers lose.[164] Kaldor Hicks efficiency is achieved if those that are made better off in theory hypothetically could compensate those that are worse off and still be better off than they were before. This would fulfil the Pareto efficiency criteria. The Kaldor Hicks theorem is the foundation for a socioeconomic cost-benefit analysis. Then the conditions "worse off" and "better off" are transformed into costs and benefits and if the benefits are greater than the costs the theorem is fulfilled.[165] The analysis in chapter 5 is mainly a cost-benefit analysis.

Why market equilibrium is considered ideal depends on that it is considered pareto optimal. At market equilibrium it is not possible to make changes in quantity of supply that are better for some without making it worse for others. Under- and overproduction both results in an efficiency loss, *a dead-weight loss*. The efficiency loss when there is underproduction constitutes all the transactions that could have occurred, but do not due to the scarcity in goods and when there is overproduction all the transactions which could have occurred, but do not due to the lack of will to pay a higher price since there is a surplus in goods.[166]

3.2.1 Conditions for market equilibrium

There are certain conditions that need to be fulfilled to be able reach market equilibrium. The first one is perfect competition signified by many different

[162] Dahlman et al., 2004, pp. 45-48.
[163] Cooter and Ulen, 2000, pp. 29-30 and pp. 39-40.
[164] Ibid. p.12 and p. 44.
[165] Dahlman et al, 2004, p. 56.
[166] Ibid. pp. 57-60.

companies producing similar products.[167] If there is a monopoly, the quantity of supply is too low and the price is too high from an efficiency point of view. Sometimes, the government intervenes to adjust a monopolistic market by enforcing competition or regulating the price charged by the monopolist.[168]

The second condition is that all costs must be internalized. In section 4.1, it was explained that companies make decision on whether to increase production or not based on the ratio between marginal cost and marginal benefit. Therefore all costs for producing a product must be taken into consideration, including external cost like air and water pollution. If this is not included, the product is sold to cheaply and from an efficiency perspective the company should produce less and sell the product for a higher price.[169] It is said to be too socially costly when a company does not take into consideration what is the most optimal production rate for the society, as compared to the company itself.[170]

The third condition constitutes that goods should be private and not public to avoid market failure. Boats, cars, clothes and food are examples of private goods and defence, lighthouses and salting of roads during winter examples of public goods.[171] Public goods have the following characteristics: *Non-rivalrous consumption* – consummation of a public good does not reduce its availability for subsequent users. *Non-excludability* – to exclude non-paying beneficiaries are so costly that no private-profit maximizing company is willing to supply the market with the good. Suppose that military defence was provided by private companies. If A bought protection, its neighbour B would benefit from A's purchase. If A is protected from foreign invasion, so is B. The incentives to buy protection from a private company are very low since most people will try to *free-ride* on others. This kind of market failure is often solved by that the government takes on the public good itself and finance it through compulsory taxation, or by government subsidies to the private companies who provide the goods or service. Basic research is an example of a public good which receives government subsidies.[172]

The final condition for market equilibrium is that the parties on the market have perfect information about the other party. Informational asymmetry occurs, for example, when a seller knows more about a good than the buyer or when the insured knows more than the insurer. In these kinds of situations informational asymmetry render difficulties in making efficient decisions. Some transactions do occur because the buyer does not have all the facts and some transactions do not occur because of the same reason.

[167] Dahlman et al., 2004, p. 61.
[168] Cooter and Ulen, 2000, p. 40
[169] Dahlman, et al., 2004, p. 62
[170] Cooter and Ulen, 2000, pp. 41-42.
[171] Dahlman et al., 2004, p. 63.
[172] Cooter and Ulen, 2000, pp. 42-43.

This is a loss of efficiency.[173] Informational asymmetry is sometimes compensated for through legal regulations. A seller of a house is, for example, responsible for latent defects.[174]

3.3 Prosperity, welfare and ethics

From a socio-economic perspective it is highly desirable that mutually beneficial transactions occur. Most transactions create satisfaction both in the form of prosperity and welfare. Prosperity is measured in money and welfare is measured in units of utility. A transaction is mutually beneficial when both parties feel that they have made a good deal. This is an example of a transaction which generates both prosperity and welfare. Suppose A has a bike she estimates to be worth $200. She eventually sells the bike for $300 to B, who estimates that the bike has a value of $400. Both A and B are very satisfied with the transaction since both feel as if they have made a profit of $100 each. Both prosperity and welfare of society increase when persons, who value certain goods the most, are their owners. This is applicable not just on goods, but on rights as well.[175]

Sometimes prosperity and welfare do not coincide. In the example with the bike, it was shown that voluntary agreements between rational persons create both prosperity and welfare. This example can be considered pareto efficient since it creates welfare without reducing the level of welfare for anyone else, but it is worth noting that a single pareto efficient agreement does not necessarily increase the total welfare of a society.[176] The fact that the Pareto efficiency theorem does not take into consideration if distribution is equal has given rise to criticism.[177] Exchange the bike in the example with a bag of groceries. Suppose that there is, besides A and B, a person, C, who has not eaten in several days. She can only afford to pay $10 for the bag of groceries. From a prosperity maximizing perspective it is still most efficient if B would buy the bag, but from a welfare maximizing perspective it should be C who gets to buy the bag. The chance that C would get to buy the bag for $10 is very slight. A will seek to maximize his prosperity, just like all other individuals do. Sometimes legal systems redistribute wealth in order to create welfare when for example tax revenues finance social allowances. A negative effect of the redistribution can be that it lowers the incentives for individuals to maximize their own welfare.[178]

[173] Dahlman et al., 2004, p. 64.
[174] Cooter and Ulen, 2000, p. 43.
[175] Dahlman et al, 2004, pp. 75-78.
[176] Ibid, p. 207.
[177] Skog and Lane, 2000, p. 56.
[178] Dahlman et al, 2004, pp. 206.

3.4 Transaction costs

Most transactions involve transaction costs. These are the costs of exchange. There are three forms of transaction costs, each representing different stages of an exchange: search cost, bargaining costs and enforcement costs. Sometimes these cost lead to that an exchange is not carried through, even though a profit would have been made and sometimes an exchange with high transaction costs is carried through which results in reduced prosperity.[179] Legal regulations are used to limit the effect of transaction costs. Informational asymmetry, described above, is one form of transaction costs and it has been explained that it is possible to alleviate asymmetry between a seller of a house and a buyer by making the seller responsible for latent defects.[180]

3.4.1 The Coase theorem and its normative effect

The Nobel Prize winner in economics of 1991, Ronald Coase, has theorized about efficiency, externalities[181], and transaction cost. In his most famous article, *The problem of social cost*, he begins his article by stating that there are other solutions than the more traditional to solving the problems of social costs, traditional being infliction of taxes or responsibility to pay damages. He argues that if A causes harm to B, we should not ask how we can restrain A from causing further harm, but if A should be allowed to harm B or if B should be allowed to harm A. It is most important to avoid the more serious injury. Choices should be made based on an evaluation of what is obtained and what is sacrificed. Is the loss of fish in the polluted river of greater value than the goods the polluting factory produces upstream?[182]

The thoughts of Coase eventually led to the development of *The Coase Theorem.* According to this theorem it is not externalities that really are the problem, it is the transaction costs. *The Coase theorem* suggest that if negotiations can be held and contracts can be agreed upon without transaction cost, they will result in contracts where resources are used efficiently, regardless of how the legal system has allocated the rights.[183] The theorem will be illustrated in an example below.

Consider a steel mill, which is using "public air" when producing steel and that the pollutions are causing bad smells and sore throats for the people living in the rented summer resort down wind. External costs are the result of decisions by both parties, the decision to pollute and the decision to live

[179] Cooter and Ulen, 2000, pp. 87-88.
[180] Dahlman et al., 2004, p. 90.
[181] An externality is a positive or negative impact on any third party not involved in transaction. These costs or benefits for the third party often derive from the use of a public good. For example, the costs imposed by an owner of an industry when using "public air".
[182] Coase, pp. 1.
[183] Skogh and Lane, pp. 62-63.

where someone is polluting. Assume that the pollution makes damages worth $100,000 per year. These damages could be put an end to at a cost of $80,000 per year, but it would only cost $50,000 to shift all the land down wind and start using it for a line of business which is unaffected by pollution. For example, start growing timber instead of renting out summer resorts. If these parties could make and enforce a contract which was in their mutual interest, there would be an efficient outcome. If the mill has a legal right to pollute, then the most efficient result would occur without bargaining; the landowner down wind would shift his business to growing timber. If the people downwind instead had the right to not have their air polluted, the most efficient result would be if the mill paid the landowner $60,000 to shift his business instead of spending $80,000 on eliminating pollution. Then both the landowner and the mill would benefit from the agreement. Suppose that pollution control instead is the cheaper option and that it only costs $20,000. If the mill had the right to pollute, the landowner would offer to pay $20,000 for pollution control. If the right was reversed, then the mill would offer the landowner $20,000 to get the permission to pollute, but this will be turned down by the land owner.[184]

So why do we have pollution in our world? Either it is because pollution is efficient and it costs more to prevent it than the damages it does, or, more likely, it is because the transaction costs to eliminate pollution are very high. Suppose that the mill has the right to pollute, but there instead of one land-owner hundreds of landowners. If there were only one landowner he would pay the $20,000 to avoid pollution, but if there are hundred landowners the face a problem called *the public good problem*. If only 90 of the landowners agree to pay, than the 10 who do not pay can free-ride on the action of the others. This creates an incentive for each landowner not to pay, since each of them figure that their individual contribution to pay or not will not make any difference.[185]

Coase realized that in reality, transaction cost could not be avoided and that the allocation of rights therefore was of importance.[186] *The normative Coase theorem*, inspired by the Coase theorem, suggests that the legal system should assign people the rights and duties that they would have had if all welfare maximizing agreements were to come true. The lawmakers should try to create laws which imitate a world without transaction costs, where successful bargaining is possible. [187]

3.4.2 Property rights

An important prerequisite for making efficient investments and resource utilization possible is the existence of property rights. Whether or not these rights will lead to efficient investments and use of resources depends on how they are drafted and their enforceability. Inefficient property rights can

[184] Friedman, pp. 2-5
[185] Ibid, p. 6.
[186] Skogh and Lane, 2000, pp. 62.
[187] Dahlman et al., 2004, pp. 103-104.

result in a lack of incentive to invest, increased transaction costs and increased costs for protecting the finished product. In general, investments are not made as efficiently as they could have been made, if it is not possible to exclude others from using the result of one's work.[188]

3.4.2.1 Patents

In the field of innovations, and for most of all intellectual property, it is problematic that one person's use of information does not exclude others from using the same information. This area also presents problems regarding the fact that the cost of producing the first product is very high in comparison to the cost of reproducing the same product. The cost of preventing others from copying your product is generally very high too. What has been described in this section bears close resemblance to public goods.[189]

It is a common economic argument that an inventor should be able to appropriate the social value of his invention. If there is no form of protecttion there is a risk that the production rate for products, which are costly to invent, would be to low. Patents make it possible for an inventor to file for infringement and claim the right to damages if someone uses his invention without permission. Patents also reduce transaction costs and make it possible for the invention to end up with the person who values it the most. The benefit of a patent is that it comes with the condition that an inventor has to make his invention known to public.[190]

Even though patents hold many advantages, they pose a serious economic dilemma. At the same time as they create incentives for inventors to invent, they create disturbance on the market by giving rise to monopolies. This leads to a number of social costs for the society. First of all, higher prices and a lowered production rate as a way for the producer to maximize his profit. Secondly, it can compromise future innovation. During the term of a patent, others who want to develop the invention or use the same technology must receive a licence from the patent holder. This could be very costly and restrain others from making something of their own ideas. It is a well-known fact that longer duration and greater breadth on patents, at least in combination, have negative effect on the social costs. The question whether the social benefits of patents are large enough to overcome the social costs does not have a clear answer.[191]

This short section on patents has been a brief background to the questions that are discussed more in depth in section five.

[188] Dahlman et al., 2004, pp. 166-167.
[189] Ibid, p. 174.
[190] Ibid, pp. 174-176.
[191] Ibid, pp. 177-178.

4 The economics of patents

When examining the issue of patent protection, we have to weigh the benefits and cost they pose on society with the interests of individuals and firms from the private sector, who are responsible for introducing the invention. The proper balance between these two conditions has yet not been established due to the complexity of the matter. The economics of patents are influenced by utilitarian theories.[192] This chapter begins with a description of the objectives of patents. This is followed by a section that outlines problematic aspects of the objectives presented. Thereafter, theories on optimal patent design are put forward. The final section of the chapter, primarily provides is a cost-benefit analysis of the presented material.

4.1 The objectives of a patent system

The objectives of the patent systems are to create an incentive to invent, induce disclosure of inventions and facilitate trading with inventions. It is in these objectives we find the social benefits of patents.

4.1.1 Create an incentive to invent

From the perspective of society it is beneficial when imitation of an invention can be rapid and free. Society could benefit from these circumstances in two different ways. Firstly, perfect competition in the market results in lower prices on goods. Secondly, others than the inventor interested in producing the invented product can avoid the costs of R&D and the price on that product can be lowered. However, one big impediment remains. If inventors would not be able to obtain commercial returns for their investments in R&D, they would be hesitant to spend their time and money on inventing. Patents have become a way to solve the problem of free-riding, a term used to describe when others than the inventor use an invention without paying for the use, which could lead to possible underproduction.[193] To promote investments in inventive activity is currently the primary objective of patents.[194]

4.1.2 Induce disclosure of inventions

If an inventor cannot seek protection for his invention there is an increased likelihood that he will keep it secret for as long as possible. From the perspective of the community it is better if an inventor holds his invention secret than to not invent at all. An invention, which is kept secret, can increase the net social benefit since the use of the invention make resources

[192] The utilitarian approach was briefly explained in section 3.1.3.
[193] Pugatch, 2004, pp. 19-20.
[194] Guellec and van Pottelsberghe de la Potterie, 2007, p. 63.

available for production of other goods.[195] However, secrecy is not optimal in creating social benefits for the society. It is costly for society when only one single manufacturer can use the invention as compared to an entire branch. Secrecy can also pose additional costs on society if an original inventor does not use his invention as efficiently as one could. The gains of the society are increased if an invention is in the hands of a person who uses it the most efficiently. The gains come in the shape of the extra release of resources the new owner creates.[196] If an inventor manages to maintain his invention a secret for a long time, it is temptable for others to try and come up with the same invention. This presents an additional problem. Keeping in mind that resources in society are limited, which was stated in chapter 4, the resources others use to produce the identical invention is a misallocation.[197]

A patent grant comes with a condition to make a detailed description of the invention public. Other advantages than the ones presented above, are that disclosure facilitate for follow up inventions and facilitate for substitutes to be invented. Substitutes are welfare increasing since they tend to lead to lowered market prices.[198]

4.1.3 Stimulate trading with inventions

Transactions costs associated with inventions are generally very high. Informational asymmetry is one factor which makes it more difficult to trade. To be able to know how much a buyer is willing to pay for a product he has to assimilate information about its technical characteristics and what prospective it has on the market. Once the potential buyer has been able to take part of all valuable information about the product, previously kept a secret, he might decide not to buy it, but to take advantage of what he has found out about the product and produce it himself. Contracts protecting secrecy, which might have been agreed up on ex ante, are often very costly to enforce in court. If the inventor decides to go to court and claim his rights as the first inventor, this is too very costly and quite difficult to prove without any public documentation supporting it. Through the creation of patents, these difficulties can to a large extent be overcome and inventions can more easily be sold on the market, through licenses for example.

A license gives another party than the inventor the right to use the invention under certain conditions.[199] From the perspective of society it is desirable that inventions can be licensed, not just for the above mentioned advantage, but also for the following reason. An inventing person or firm is not necessarily the one who can manufacture a new invention the most efficiently or further develop it.[200] For companies, which do the inventing early on in the process, but do not have the prerequisites to commercialize

[195] Pugatch, 2004, p. 20.
[196] Ibid.
[197] Ibid.
[198] Guellec and van Pottelsberghe de la Potterie, 2007, p. 75.
[199] Ibid. pp 88-89.
[200] Scotchmer, p. 163.

the invention, patents become very important. They are dependant on the possibility to successfully trade with their inventions.[201]

4.2 Problematic aspects of patents

The objectives of patents present many benefits, but this section shows that these benefits are compromised by several factors. Namely, monopolistic markets, sequential innovation, strategic patenting, strategic litigation and the fact that many firms find patents to be less important and less efficient as a means of appropriating the returns of investments compared to other methods such as secrecy and lead time. These various factors impose different types of social costs.

4.2.1 Monopolistic markets

Despite the great social benefits patents create, it is difficult to disregard the fact that they result in market monopolies. Consequences of monopolistic markets are deadweight loss and possible decline in efficiency of production.

A monopolistic market is, as previously has been explained, a form of market failure. In the lack of competition, a monopolist can decide upon whatever price and production rate he wants. His only limitations are the costs of production and the demand on the market. He will most likely choose a price that is higher than it would have been under market equilibrium and a production rate that is lower than it would have been under market equilibrium. This results in deadweight loss, which has previously been mentioned in section 4.2. When consumers refrain from buying a service or good due to the scarcity of goods or high prices there is an efficiency loss. Pareto efficient agreements would have occurred if the market was competitive.[202]

A theoretical solution to the problem of deadweight loss is price differentiation. Suppose that a firm could find out the capability and willingness to pay of each consumer and charge her on the basis of their findings. This would make it possible to sell goods to all consumers who are willing to pay more than the marginal cost of producing them. What makes this solution just theoretical depends on primarily two obstacles. The first is the difficulty of gathering the information about every consumer. They are in general not interested in declaring how much they are willing to pay for a certain good. The second complication is the risk that a second-hand market develops. This could happen if the consumers with the highest willingness to pay would ask those with the lowest willingness to pay if they could buy the goods from them in stead. A producer would not have any control over a second-hand market and it would eventually drive down the prices. The problem with second hand markets is the major argument used by the drug

[201] Mazzolini and Nelson, 1998, p. 1040.
[202] Dahlman et al., 2004, pp. 146-148.

industry to not lowering their prices on their products in poor countries. They argue that a second-hand market would decrease the revenues they need to finance their R&D.[203]

The second negative effect of a monopolistic market is that they can result in a decline in efficiency of production. Production efficiency aims at producing a good at the lowest possible cost. On a perfectly competitive market, production efficiency is a condition for being able to stay in business. In the lack of competition, a monopolist does not have to act as efficiently.[204]

4.2.2 Cumulative research and sequential innovation

Einstein once declared: ”If I have seen further it is because I am standing on the shoulders of giants.” It is a well-known fact that inventors learn from their predecessors and it is therefore in the interest of society that this opportunity is made possible. The problem lies in how earlier inventors should be compensated for what they have invented while at the same time giving later inventors an incentive to invest.[205]

At different stages in the patent process, the patent examination offices and courts decide whether or not innovations infringe upon earlier works. Their conclusions are of great importance since they affect the incentives to invent products that build on previous inventions. If the pace of innovation is too slow it increases the negative effects of deadweight loss. It is also socially costly when inventors are inhibited to improve existing inventions.[206]

4.2.2.1 Three types of cumulativeness

Many technologies have a high degree of cumulativeness, where innovations build on what has previously been developed and discovered. These technologies are especially biotechnology, computer software and computer hardware. Cumulativeness can be divided into three different types. The first one is when a basic invention leads to a variety of different second-generation innovations. The laser can be mentioned as one example. It was invented in the 1950s and has made several other inventions possible. As late as 2002 at least 224 patents relating to laser were issued at the USPTO. The second type occurs when several first-generation products are needed to develop a new product. These are often called research tools. Consider a bioengineered crop seed as an example. For it to be developed it might require different genes that code for characteristics such as durability and pest resistance, but also a tool to insert the genes in the germplasm. The last type of cumulativeness is when products are successively improved. In this case there are no basic inventers whose knowledge is being used, just a

[203] Guellec and van Pottelsberghe de la Potterie, 2007, p. 79.
[204] Guellec and van Pottelsberghe de la Potterie, 2007, pp. 148-149.
[205] Scotchmer, 2004, p. 127-129.
[206] Chang, 1995, p. 34-35.

line of improvers.[207] The firm which has made an improvement on an already patented product receives a patent on the improved feature alone and has to be granted licences on the technological features of the earlier product.[208]

Type 1 and type 2, are examples of the relationship between basic and applied research. Basic research can be defined as "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena or observable facts, without any particular application of use in view."[209] Applied research can be defined as "original investigation undertaken in order to acquire knowledge...directed primarily towards a specific practical aim or objective."[210] Or put in comparison: "While basic research is considered to create knowledge that is in itself too broad or too general to be directly applied as a source or production for a specific purpose, applied research is considered to create knowledge that has a direct, specific and applicable use."[211] Basic research creates a foundation for applied research and is used to produce innovations, which can be sold on the market.[212] In more recent years it has become more difficult to distinguish between basic and applied research, especially in the field of biotechnology. This is due to that practical applications of basic research is now much more foreseeable than before, which makes it less complicated to obtain patents.[213] The following paragraphs on different types of cumulativeness assume that basic research is patented.

4.2.2.1.1 Basic inventions

When inventions derive from basic research there are some problematic aspects. Both generations of inventors must cover their individual costs as well as the collective costs. When the application is much more profitable than the basic research, much of the profits must go to the first generation inventor to be able to cover the collective costs. One way to solve this difficult situation is licensing.[214] The next couple of paragraphs are devoted to how licensing works in the case of basic and applied research.

In general, basic research does not have any value as a stand-alone product. A commercial value can only be assimilated through licensing. No firm would be interested in financing basic research if it was not possible to profit from second-generation inventions. When a second-generation invention is patentable, but infringes on an earlier patent it is called that the two firms have blocking patents. This can be solved through licensing. Negotiations on a license have two important determining elements. The first one is *threat points*, which represents how much profit a firm can make

[207] Scotchmer, 2004, p. 132.
[208] Chang, 1995, p. 36.
[209] Pugatch, 2004, p. 17.
[210] Ibid.
[211] Ibid.
[212] Ibid.
[213] Rai and Eisenberg, 2003, p. 289.
[214] Scotchmer, 2004, p. 135.

if it decides to not agree on a licensing contract. The second element is *bargaining surplus*. This is the amount which will be added to the total wealth of the firms if they agree on the licensing contract. Each firm is guaranteed the threat points, but the difficulty lies in how the bargaining surplus is divided. Scotchmer, the cited author, assumes that the surplus is divided equally in her theories.[215]

The license agreement can either be agreed upon ex ante, before the inventor invests, or ex post, after the inventor has made investments. So what are the advantages and disadvantages of ex ante and ex post license agreements? Assume two firms licence ex post, firm A representing the first-generation invention and firm B representing the second-generation invention. B has the disadvantageous position that it can not put its product on the market if A do not agree on a license, but has at the same time spent a lot of money on R&D. Conversely, A has most likely spent even more money on R&D and needs to enter into license agreements to cover its costs. Yet, firm A must be said to have the better position. Firm A can choose to license with a different party, if it does not like the conditions firm B has to offer, while firm B has no other alternative. If firm A and firm B can agree on letting the new product on the market and sharing the profits equally there is no disad-vantage in making a licence agreement ex post compared to ex ante. On the other hand, if a license agreement is not agreed upon ex ante, firm B might never invent in the first place due to fear of licensing fees so high that it can not cover the cost of R&D. There is a bargaining surplus to be achieved if an ex ante agreement is made. Firm A can make sure that the investment in the second product goes forward by agreeing on a lower licensing fee then it would have done ex post when B's cost are already sunk.[216]

Based on what has been described a number of conclusions can be drawn. Firstly, ex ante agreements can facilitate for the production of second-generation products. Secondly, if the combined profits of firm A and firm B are close to zero, then firm A will most likely make negative profit. This can be resolved if the total profits are increased. It would be possible if the patent life was prolonged, but this would at the same time increase the deadweight loss. Thirdly, firm B's invention is not made possible without firm A's invention and therefore society's interest are foremost aligned with firm A. Fourthly, a research exemption[217] could be advantageous for firm A since it makes it possible to bargain ex post. The bargaining position ex post is a more preferable bargaining position for firm A since the second innovator's costs have sunk by then. To overcome the obstacle of asymmetric information on the value of an innovation in ex ante negotiations, royalty payments should be linked to the actual value of the invention.[218] Scotchmer concludes by stating that basic research should be

[215] Scotchmer, 2004, pp. 136-137.
[216] Ibid. pp. 136-138.
[217] A research exemption allows researchers to use patented inventions for their research without infringing on other's patents. Read more about research exemptions on page 50.
[218] Ibid. p. 138-142.

financed by public sponsors since it is so difficult to appropriate its value. A researcher can generally not negotiate license agreements before his costs are sunk, which puts him in a less advantageous bargaining position than the second-generation innovator.[219]

4.2.2.1.2 Research tools

Research tools differ from basic inventions regarding licensing. An inventor in the field of biotechnology often needs several different kinds of research tools to come up with one applied innovation. This requires that an inventor receives licenses from several different licensors. Researchers in biotechnology have expressed concerns that this might affect the pace of technological progress negatively. Compared to basic inventions, which are licensed through negotiations, research tools are more often licensed or sold anonymously at a single price. When a research tool is sold anonymously to several different users at a fixed market price, the price is determined by if there are any substitutes and the price of the substitutes. Social loss occurs if the patent on a research tool is broader than necessary to cover the cost of R&D and if the price of the research tool is so high that it discourages others from buying it, especially when it would have led to production of new inventions.[220]

It was previously explained that an inventor often needs several different research tools to invent a new product. When they are sold anonymously by different firms, it might lead to that the total price for the research tools are too high and that the second-generation inventor has to refrain from buying them. If a research tool is licensed, other obstacles occur. Assume several patent holders are competing for the profits of a second-generation invention, and all their research tools are required for this invention. It could become difficult to resolve how the profit should be divided, especially between the different licensors and there is a risk of bargaining breaking down. There is a concern among biomedical researchers that the obstacles to licensing will have negative effects on future research. Scotchmer suggest joint ownership of research tools or patent pools as solutions.[221]

The problem of research tools is also discussed in an article by Heller and Eisenberg and they refer to the current situation as the “tragedy of the anticommons”. Tragedy of the commons is a well-known concept within law and economics as well as law and philosophy. It refers to the situation when people overuse shared resources. With the concept the tragedy of the anticommons, Heller and Eisenberg wish to explain the opposite situation. “People underuse scarce resources because too many owners can block each other.”[222] The scope of the article is limited to biomedical research. The authors argue that IPRs must be used more carefully, otherwise there is a risk that many promising lines of research and product development never

[219] Scotchmer, 2004, p. 156.
[220] Ibid, pp. 133 and 142.
[221] Ibid. pp. 133 and 142-143.
[222] Heller and Eisenberg, 1998, p. 698.

takes place. They refer to two circumstances which give rise to biomedical anticommons. The first one is the many coexisting intellectual property rights in upcoming products that could lead to difficulties in procuring a complete set of licenses for new products and processes. Firms might instead redirect their assets to less promising projects where there are fewer license barriers. The second circumstance is the fact that too many first-generation patent holders can stack licenses on upcoming products. A license can take different forms; royalty on sales or the right to an exclusive or non-exclusive license on future products for example. If the possibility to prosper and make profits is uncertain, it is far from a matter of course that the parties will succeed in their bargaining.[223]

Heller and Eisenberg further discuss explicit factors that might result in a breakdown in bargaining. New research tools are invented by diverse organisations and by firms both in the public and the private sector. Heller and Eisenberg fear that the diversity also leads to heterogeneous interests and that this makes it more difficult to reach an agreement. If two possible licensors have conflicting agendas, they can refuse to enter into an agreement. A question of conflict could for example be when the National Institute of Health is more interested in promoting public health than creating large profits. A second problem occurs through the parties' uncertainty over the value of their IPRs. A licensor has a tendency to overestimate the value of his research tool. Heller and Eisenberg refers to a number of court cases when arguing that the likelihood of unsuccessful bargaining is great when two or more patent owners each believe that they could dominate the market.[224]

Walsh et al. argue against Heller and Eisenberg's findings. They consent to the fact that the patent scene has become more complicated since patenting of research tools began, but argue that the situation with anti-commons have not been especially problematic and "has not yet impeded biomedical innovation significantly."[225] They base their arguments on interviews with biotechnology and pharmaceutical firms. According to the results of the interviews, almost none of the firms had given up projects of promising character due to problems to access research tools. Even though they admit that they do not have any statistics on the number of projects never undertaken at all, as compared to given up once initiated, they argue that patents on research tools infrequently constitute an obstacle to promising projects. Both public and private companies have found ways to work around possible obstacles to proceeding with their research. The solutions are a combination of licensing, inventing around patents, infringement, using tools which are in the public domain and lastly, question validity of patents in court. Yet, Walsh et al. express concerns about the social costs some of these solutions impose. Inventing around is for example a social waste and litigation impose high social costs. Nevertheless, they argue that social welfare might not be higher with low-cost access to research tools if it

[223] Heller and Eisenberg, 1998, p. 699-700.
[224] Ibid. pp. 700-701.
[225] Walsh et al., 2003, p. 331.

reduces the incentive to invent them. They do not exclude that a situation will occur where a patentee refuses to license an important research tool and blocks important research and therefore they suggest that patent laws should provide improved research exemptions to handle this kind of situation. [226]

Research exemptions allow researchers to use patented inventions for their research without infringing on others' patents. This can alleviate the problems with basic inventions and cumulative research and also contributes to attenuate the negative effects of deadweight loss. Most European countries have statutory exemptions, which state that patents do not extend to experimental use of the subject-matter of a patented invention. Other countries, such as Australia, Canada, New Zealand and the US only have non-statutory research exemptions. In all of these countries the scope of the research exemptions are unclear.[227] In the US, the research exemption was weakened in the case Madey v. Duke in 2003. The CAFC argued that previous court rulings had clarified that the experimental use defence in US law was very narrow. In this case, the CAFC found that the experimental use defence only applied if a patented invention was used "solely for amusement, to satisfy idle curiosity, or for strictly philosophical inquiry," and could not be used "in furtherance of the alleged infringer's legitimate business". The CAFC made no difference between non-profit and profit organizations.[228]

4.2.2.1.3 Quality ladders

On a quality ladder a product is improved continuously. Turnover on the market can be rapid and market dominance is lost as soon as an improved product appears. The question is if large enough incentives to invest in improvements can be created when profits to cover costs can not be guaranteed. At the same time rapid progress has its advantages. Scotchmer suggests that the inventive step must be high enough that firms will not invest in improvements that are of little importance. Leading breadth should also be considered. It sets the level of quality an improvement must have to avoid infringing on a previous patent and it should be so large that it gives the investors a possibility to recoup their costs. It is actually preferable that the improvement infringes on the previous patent so that the previous market leader can get a share of the profits on the improvement. It is a way to cover the cost he has had for developing his product.[229]

4.2.3 Strategic patenting

The previous section began with the quote where Einstein considered himself to be standing on the shoulders of giants. Shapiro, on the other hand, uses a pyramid as metaphor to describe the current situation, a situation where strategic patenting has had a compromising effect. Today's

[226] Ibid. pp. 331-336.
[227] Dent, 2006, pp. 8, 17-21.
[228] Miller, 2003, p. 1.
[229] Scotchmer, 2004, pp. 146-152.

researchers stand on the top of a huge pyramid of knowledge where every building block represents inventions and innovations by different persons. If someone wishes to place a new building block at the top of the pyramid he would first have to get the permission and most likely pay every person who has previously placed a block in the pyramid. It is likely that it would take longer time for the pyramid to reach new heights with this system.[230]

Patents give a patent holder the right of exclusive use of his product. In contrast, strategic patenting can be defined as different ways of using a patent that go beyond exclusive use in order to gain financially. Strategic patenting can be defensive or offensive. Firms that choose to patent *defensively* do not in general need patents to appropriate returns from inventions and would just rely on secrecy and lead-time if the innovative climate allowed for it. Instead these firms patent defensively in order to prevent other firms from patenting what they have invented and avoid a potential lawsuit. Instead of patenting firms could choose to publish the invention, which would prevent others from receiving a patent, and avoid the costs of filing for a patent. Many firms choose not to publish due to that a patent examiner might fail in finding all prior art and grant a patent even so. To get the patent declared invalid through litigation is often very costly and time-consuming. Firms also patent defensively to improve their bargaining position in relation to other firms. In many industries patents are used in negotiations to gain access to other firm's patent portfolios. Other firms choose to patent *offensively*. This conduct aims at preventing or blocking other firms who would like to put similar inventions on the market by building a "wall" of patents around their original invention. The offensively patenting firm does not necessarily intend to commercialize these other products, or even license them.[231]

The various measures of strategic patenting are often responses to the behaviour of competitors. If a company wishes to gain freedom to operate and none of the company's competitors patent their inventions, the company would not have to patent either. On the other hand, if the competitors patent extensively, the company would have to patent too in order to survive. In comparison, the "zero patents" equilibrium is pareto superior, taking into account all the costs involved with the "many patents" equilibrium. This conclusion is limited to the circumstance that companies only patent to gain freedom to operate. [232] Strategic patenting can be defended from the point of view of private companies, but is difficult to defend from the point of view of society. When taking into consideration the costs of working the patent system, but not producing more inventions than at the "zero patent" equilibrium, patent races are a waste of resources.[233]

[230] Shapiro, 2001, p. 120.
[231] Arundel and Patel, 2003, pp. 2-4.
[232] Guellec and van Pottelsberghe de la Potterie, 2007, pp. 80-81.
[233] Ibid, pp. 81-82.

4.2.3.1 Patent races and patent thickets

Strategic patenting lead to patent races, a situation where two or more firms separately spend time and money into pursuing the same innovation, but only one firm gets the patent.[234] Patent races take place in several industries, for instance the semi-conductor industry. Before the 1980s, a very limited amount of patenting was taking place in this industry. Most firms considered patents an inefficient way to appropriate returns given the rapid pace of technological change within the industry and relied on lead time advantages instead. By the mid 1980s, Texas Instruments decided to enforce some of the patents they had held for a number of years but never before had demanded royalties on. This proved to be a success and by the late 1990s, Texas Instruments was making $800 million in licensing revenues per year. This was about 55% of the company's total income. The success of Texas Instruments raised the interest in patents in the semi-conductor industry significantly.[235]

Excessive patenting results in patent thickets. They are the web of overlapping patents an innovator has to get through in order to commercialize his product. The innovator has to obtain licenses from the owners of all the patents that he infringes in order to put his product on the market. This problem is called the complements problem.[236] It has become very common in many industries to apply for patents on each integrated component in a product. The result can be hundreds of patents, all originating from a single product. For the patentees, this constitutes a very strong weapon when trying to prevent others from entering the same product market. Assume a company X, has a product protected by hundreds of patents. X claims that company Y is infringing on their product. It would be very costly for Y to prove their right in an infringement suit when they have to fight such a large number of patents. They will have to win every dispute on each patent, or they will have to face large royalties, to be able to commercialize their product. Some patentees have realized that they can increase their royalties by delaying the issuance of their patents. Competitors, unaware of that another company already has invented a similar product, have made such large investments that they would lose even more if they do not agree on licenses. This is referred to as the hold-up problem.[237]

The complement problem and the hold-up problem impose costs on society. The fact that companies have to agree on several different licensing agreements might slow down innovation, which is considered socially costly. Entry barriers become very high for new firms and already existing firms might be forced to conduct research in fields where fewer patents have been issued.[238] Some companies might avoid the risk of infringing on someone else's patent and refrain from commercializing certain products all

[234] Scotchmer, 2004, p. 112.
[235] Jaffe and Lerner, 2007, p. 57.
[236] Shapiro, 2001, p. 122-123.
[237] Lemley and Shapiro, 2005, pp. 81-82.
[238] Arundel and Patel, 2003, p. 4.

together.[239] The situation is especially troubling for small and medium size enterprises as well as enterprises in developing countries. They do not have the economic resources to engage in strategic patenting.[240] "It is an expensive process, and large multinational companies will put a patent on everything that moves. Smaller companies, which may be more innovative, won't be able to afford to do this."[241]

4.2.3.2 Evergreening

Evergreening refers to the conduct where a patent holder, who wishes to prolong the protection on his innovation, applies for secondary patents on technologies relating to, or deriving from the original patent. This prevents others from producing copies of the initial patent after it has expired and this practice has become fairly common in the pharmaceutical industry. Evergreening has been criticized for making it feasible to extend the term of protection even though the patentees only contribute with trivial changes.[242] These modifications can be in the manufacturing process, the colour of the pill or the dosing range.[243]Just like any other strategic use of patents, this is not contrary to law.[244] Based on what has been presented previously in this thesis, evergreening impose social costs on society by extending the negative effects of deadweight loss and stifling the pace of technological progress.

4.2.3.3 Cross-licensing and patent pools

Cross-licensing can alleviate some of the side-effects of patent thickets. They are often negotiated when two firms are producing products that could infringe on the other firms' patents. Instead of actively pursuing to block each other, which could have detrimental effects on their businesses, they agree on a cross-license. The cross-license gives the firms the right to use the other firm's patents. Cross-licenses can of course contain restrictions, which limit the access to the other parties' patent portfolio. Some cross-licenses are royalty-free while others might include royalty payments for one of the parties. When one party pay royalties it is often due to that the other parties' patent is much more valuable to get access to. [245] Large scale cross-licenses have become more and more common, especially in the semi-conductor industry. In 2004, Samsung and Sony agreed on a cross-license where Samsung was given access to 94% of Sony's 13,000 US patents and Sony was given access to a similar percentage of Samsungs 11,000 US patents. In 2005, LG Electronics and Matsushita agreed on a similar cross-licence.[246]

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[239] Shapiro, 2001, p. 126.
[240] Macdonald, 2002, p. 18.
[241] Quote found in Macdonald, When Means Become Ends, p. 18. Original article: German government opposes software patents, available at: http://news.zdnet.co.uk/software/0,1000000121,2099533,00.htm (accessed 10 Feb, 2008).
[242] Chalmers., 2006, p. 1.
[243] See http://www.egagenerics.com/gen-evergrn.htm
[244] Tong, 2002, p. 787.
[245] Shapiro, 2001, p. 127.
[246] Guellec and van Pottelsberghe de la Potterie, 2007, p. 101.

Licenses are generally beneficial to society. They save on resources since less duplication of research takes place. One of their negative effects is the fact that they reduce competition.[247] Cross-licensing might be able to ease some of the worst side-effects of strategic patenting, but it cannot solve the fact that firms look at patents, and not innovation, as the way to make revenues. For many firms, patent royalties are more profitable than a product line in itself. [248] It also becomes clear that cross-licensing is only an option for those who can offer something in return. Just like licensing in general, the coordination of cross-licenses poses a problem from a competition perspective. It should not be taken for granted that cross-licenses always benefit the public.[249] They can both be tools of collusion and barriers to entry.[250]

Patent pools are another way of solving the complements problem. Patent pools consist of several different patents owned by two or more firms. The firms have agreed to license or cross-license their patents as a package to third parties and to share the revenues. Under circumstances when these patents represent technologies that are all needed to produce a certain product or to put a certain technique into practice, patent pools can make access easier and less costly. The cost of a license from a patent pool is generally lower than the cost of licenses from each firm. When firms license individually they can take advantage of their monopolistic positions and charge a higher price than they would do in a patent pool where the collective gains are prioritized. Monopolist pricing causes problems if it leads to that a firm in need of license agreements from several different firms to realize his product, might not be able to afford them. Patent pools on the other hand, make it possible for the licensors to agree on a price which is collectively reasonable. Patent pools create social benefits when reduced licensing cost leads to greater diffusion of technology. On the other hand, they can just like cross-licensing agreements be costly due to reduced competition. Patent pools are of great interest to competition authorities. In order to prevent a small group of firms from taking complete control over a certain field of technology, competition authorities have set up a number of requirements which must be met. The most important is that it is only allowed to form a patent pool with complementary patents and not with substitute patents, which are competing techniques.[251]

4.2.4 The use of litigation or the threat of litigation

Facing the risk of having to waste resources on litigation reduces the incentive effect of patents. Patent lawsuits are costly. In the US, litigation costs vary on average between $1 million and $3 million or about $500,000 per patent claim. It is not uncommon that the litigation costs are much

[247] Guellec and van Pottelsberghe de la Potterie, 2007, p. 99.
[248] Macdonald, 2002, p. 21.
[249] Shapiro, 2001, p. 127.
[250] Guellec and van Pottelsberghe de la Potterie, 2007, p. 101.
[251] Ibid, p. 102.

higher than the value of the disputed patent. Litigation costs for Europe range between €50,000 and €500,000 per lawsuit and country.[252] Due to the fact that patent litigation is both costly and risky, even the threat of having to involve in infringement lawsuits is enough for some firms to agree on paying royalties or stop producing a certain product all together.[253]

The number of patent lawsuits has increased significantly since the 1980s and can, to a large extent, be explained by the general increase in the number of patents granted during the same time period.[254] Research shows that the occurrence of patent litigation varies greatly depending on industry and firm size. High value-patents are involved in litigation more frequently and make up a proportionally larger share of the overall 2% litigation rate. Patents belonging to a small firm face a higher risk of being contested in court. Firms with large patent portfolios are less likely to be involved in lawsuits as well as firms in concentrated markets where a few firms hold all dominating patents.[255] These findings imply that the incentive effect of patents is relatively limited for small firms and greater for those holding a dominant market position.[256]

There is growing evidence that some patentees use strategic patent litigation to improve their market position. Some firms with dominant market positions threaten with or file lawsuits against actual and potential competitors. Others threaten with or file more opportunistic lawsuits with an ambition to gain on settlement payment. There is a social loss in strategic patent litigation since it limits competition.[257]

Over the past decade, a new type of patent enforcers has entered the patent scene. They are called, quite derogatory, for patent trolls. The term was coined in 2001, and refers to "an entity that makes money from a patent solely through litigation or licensing and not from manufacturing or developing the patented invention."[258] When patent trolling is used as a verb it refers to "the action of hunting down and acquiring unused patents to enforce against any company using similar technology to the patent."[259] Instead of patent troll, the Federal Trade Commission uses the term "non-practicing entities".[260] The patent troll phenomenon has taken place mostly in the US. The reasons why it has not spread around Europe are most likely that the costs of litigation are too high when there is no court system for patents that cover all European countries, European courts are generally less pro-patent compared to the US courts and fewer patents of poor quality has been issued in Europe.[261] Between 2002 and 2006, patent infringement

[252] Scotchmer, 2004, p. 200.
[253] Jaffe and Lerner, 2007, p. 76.
[254] Scotchmer, 2004, p. 203.
[255] Ibid, pp. 200-203.
[256] Bessen and Meurer, 2005, p. 26.
[257] Ibid, pp. 14 and 26.
[258] Gregory, 2007, p. 291.
[259] Ibid, pp. 291-292
[260] Ibid,. p. 299.
[261] Guellec and van Pottelsberghe de la Potterie, 2007, p. 96.

lawsuits filed by patent trolls represented about 2% of all lawsuits filed.[262] This is a fairly low number, but it is impossible to estimate how many companies that have agreed on paying licensing fees to patent trolls to avoid a lawsuit. The number is most likely not insignificant.

4.2.5 The importance and effectiveness of patents

This section present statistics of how much different industries patent, how important patents are to certain industries and how effective they are as means of appropriation. The most detailed surveys on how important patents are to R&D performing firms are the Carnegie Mellon Survey and the PACE survey. The Carnegie Mellon Survey was conducted in the US in 1994 and targeted R&D laboratories in the US manufacturing sector with more than $5,000,000 in sales or more than 20 employees.[263] The PACE survey was conducted in Europe in 1993. This survey targeted 500 of the European Union's largest R&D performing industrial firms. The questionnaires were sent to the firms and not to the laboratories directly as in the Carnegie Mellon Survey.[264] Overall, these surveys show that patents seldom are of greater importance than secrecy and lead time advantages.

4.2.5.1 Patent propensity rates

One of the fields of examination in the surveys was firm's propensities to patent. Table 1 and table 2 feature some of the findings. These tables have been taken from a more recent article by Arundel.[265]

Table1 Percent of innovations for which a patent application was made by large firms in the United States: 1991 - 1993 (R&D-weighted)

Sector	**Products**	**Processes**
Pharmaceuticals	96	42
Computers	56	28
Electronic components	35	9
Semiconductors	49	21
Communications equipment	60	49
Medical equipment	68	32
Precision instruments	41	24
Aerospace	51	36
All firms	*52*	*33*

Original source: Cohen et al, 1997, Graph 6.

[262] Gregory, 2007, p. 306.
[263] Cohen et al., 2000, p. 5.
[264] Arundel et al., 1995, p. i.
[265] Arundel, 2001, pp. 5-6.

Table 2 Percent of innovations for which a patent application was made by large firms in Europe: 1990 to 1992 (Sales-weighted)

Sector	Products	Processes
Pharmaceuticals	79	46
Office & computing equipment	57	21
Electrical equipment	44	22
Communication equipment	47	23
Precision instruments (incl. Medical)	56	47
Other transport equipment (aerospace)	31	11
Transport & telecom services	21	12
All firms (sales weighted)	*36*	*25*
All firms (R&D weighted)	*44*	*26*

Original source: **Arundel** & Kabla, 1998, Table 1

The difference in results can to some extent be explained by the fact that the estimates have been weighted by different methods. When the European results for *all firms* are R&D weighted, they come closer to the US result for *all firms.* The different outcomes could also have been affected by the different sampling methods; the US survey sampled R&D laboratories and the European survey sampled firms.[266] The overall results show that American firms have a higher propensity to patent. The pharmaceutical industry has the highest propensity rates in both surveys. They results also show that process innovations are patented less frequently than product innovations. These patent propensity rates provides some information on how important patents are to R&D performing firms, but it is of greater interest to study how important patents are in comparison to other means of appropriation.[267]

4.2.5.2 The value of patents to patentees

To what extent do firms chose patents or other forms of protection for their inventions? The first survey conducted on this matter was concluded in 1983 in the US. It is referred to as the Yale Survey and its results were rather surprising to many. This survey showed that patents were not as important as a mean of appropriation as one had thought. Many survey participants ranked secrecy, lead time, moving quickly down the learning curve and sales and service efforts higher. For processes it was considered the least effective way to prevent duplication and secure royalty income, while the figures were somewhat higher for products.[268]

The Carnegie Mellon Survey confirmed many of the findings of the Yale-survey. It examined the effectiveness of the following appropriability mechanisms: patents, secrecy, lead time, complementary sales and services and complementary manufacturing facilities. Effectiveness was measured in how effective each different mechanism had been in protecting each firm's competitive advantage for their product and process innovations. Most firms used more than one or several appropriability mechanisms. The usage of mechanisms varied from industry to industry. Just to mention some examples, for product patents R&D intensive industries, like the pharmaceutical industry, considered most of the mechanisms to be effective. The semiconductor and machine tool industries, on the other hand, reported

[266] Arundel and Kabla, 1998, pp. 132-133.
[267] Arundel, 2001, pp. 5-6.
[268] Levin, et. al., 1987. p. 794.

high scores only on secrecy and lead time. Some industries relied only on one mechanism; the computer, steel and car industries relied on lead time. Regarding process patents, secrecy was the most dominant mechanism. Some industries, like the electrical equipment ranked all mechanisms low and that could be explained by the fact that it is difficult to appropriate the value of the invention overall. Sometimes several of the mechanisms are used for one product, depending on what stage they have reached in the innovation process.[269]

When considering the effectiveness of the different mechanisms for appropriation in both product and process patents, many participating firms concluded that patents in comparison with other mechanisms were quite ineffective. Patents were, given the lowest score out of all mechanisms by all industries except for medical equipment, drugs, special purpose machinery and computers. None of the industries, including the just mentioned, scored patents as the most effective appropriability mechanism while secrecy and lead time held the position as most effective.[270]

In the PACE survey, the overall results showed that the respondents ranked patents as more important than the respondents in the Carnegie Melon Survey. It has to be taken into account that the PACE survey did not ask how effective the different methods of protection were, like the Carnegie Melon Survey, but how important the different methods were to protect innovations from copying. The PACE survey showed that patents and lead time advantages were most and equally important for product innovations. 66.2% respectively 66.8% of the survey participants considered these methods to be very or extremely important resulted. These methods were closely followed by secrecy (54.1%), technical complexity (44.8%) and frequent technical improvements (42.6%). The results were different for process innovations. Secrecy was undoubtedly the most important method of protection with a score of 64.8%. Technical complexity, patents and lead-time advantage had scores in the range of 46.5% to 45.7%.[271]

The importance of each protection method varied depending on firm size, with higher scores for larger firms. The figures also varied between different countries. When comparing the largest countries participating in the survey, Germany, Italy, France and the UK, the importance of patents and lead time for product innovations was about the same in all countries except from Germany. The scores in Germany were almost 15% higher for patents and lead time compared to an average of the other countries. A final difference in importance could be found when industrial sectors were compared. Just like in the Carnegie Melon Survey, patents on products were most important in the pharmaceutical and chemical industries. In less R&D intensive industries, fabricated metals, basic metals and utilities, patenting is the least important. Patenting processes is most important in the industries of pharmaceuticals, petroleum and chemicals and least important in the

[269] Cohen et. al., 2005, Pp. 5-7.
[270] Cohen et al., 2000, pp. 9-10.
[271] Arundel et al., 1995, p. 48.

industries of aerospace, telecommunications equipment and electrical equipment [272]

The next couple of paragraphs focus on why firms choose to patent. The surveys show that the most important reason for both American and European firms to patent is to prevent others from copying their invention or innovation, but firms also choose to patent for other more strategic reasons as the table below shows.

Percentage of European and American firms that rate each reason to patent as important[273]

Reasons to patent	United States	Europe
Products innovations		
Evaluate performance of staff	7	17
Obtain license revenue	30	36
Use in negotiations	48	69
Prevent infringement suits	61	73
Prevent copying	96	94
Process innovations		
Evaluate performance of staff	7	16
Obtain license revenue	26	32
Use in negotiations	40	58
Prevent infringement suits	50	63
Prevent copying	81	83

The figures for US firms indicate that patenting to a great extent is about blocking competitors. In comparison with European firms they have lower rates for obtaining licensing revenues and using in negotiations. This could be interpreted as a lower interest in sharing information compared to European firms and a more independent approach to innovation and how to appropriate the returns thereof.[274]

4.3 Alternative incentives

The empirical evidence above shows that while patents are of little importance to many R&D performing firms they are of great importance to some, especially in the pharmaceutical industry. However, patents are not the only way to give inventors an incentive to invest in knowledge. This section considers other forms of policies used by governments to encourage innovation, but first some statistics on the R&D expenditures in Europe and the US is presented.

[272] Arundel et al., pp. 48-51.
[273] Arundel, 2000, pp. 13-14.
[274] Ibid, pp. 12-13.

	Europe	US
GERD: Gross expenditure of R&D (billion USD)[275]	231	334
R&D expenditure by business enterprises, as % of GERD[276]	55	65
R&D expenditure by government, as % of GERD[277]	35	28
R&D expenditure by others, both domestic and foreign, as % of GERD.[278]	10	7

As we can see, business enterprises spend significantly more on R&D compared to the governments, especially in the US.

The policies used by governments to encourage innovation can be divided into three different categories: The first is the public research system. This research is performed by universities and public laboratories and is mainly funded by governments, indirectly by the tax payers. They perform basic research, generic research and research aimed at the collective needs of citizens, in areas such as defence, health and space. The funding of the research is generally not conditioned with certain results.[279]

The second category is public funding of research performed by private businesses. Most of the research performed by private businesses is generic or applied. The funding comes in various forms and is as follows: *Public procurement* – the government acquires research results from private businesses. The ownership of the research results are transferred to the government. *Research subsidies* – the government sponsor specific research projects performed by private businesses. The projects generally have objectives beneficial to society, for example, how pollution can be lowered. The results belong to the private party. *Prizes* – payments by the government to a researcher conditional on delivering a specified invention. These prizes can be aimed at a specific researcher or offered to any firm that wants to compete. It is the government that eventually has the control over the results. *Soft loans* – can take the form of reduced interest rates or reimbursement by the government either with or without a condition of successful research. The ownership of the research stays with the private business. This kind of funding was, for instance, used by European governments to finance Airbus. *Tax breaks* – this is the final form of public funding. Research performing companies can be granted reduced taxation on their profits equal to their R&D spending. This has become a quite common practice in OECD countries.[280]

The third category is IPRs and patents in particular. A patent monopoly makes it possible for the patentee to charge customers with a higher price,

[275] OECD Science, technology and industrial scoreboard for 2007, p. 27. Available at: http://lysander.sourceoecd.org/pdf/sti2007/922007081e1-a-4.pdf
[276] Ibid, p. 29. Available at: http://oberon.sourceoecd.org/pdf/sti2007/922007081e1-a-3.pdf
[277] Ibid.
[278] Ibid.
[279] Guellec and van Pottelsberghe de la Potterie, 2007, 55-56.
[280] Ibid, pp. 56-57.

but a patent only impose costs of invention on its users, and not more generally on the taxpayers. There is no guarantee that government funded inventions create benefits for individual taxpayers that outweigh the taxpayer's share of the costs. Compared to the other forms of funding, patents do not generate an income to its owner unless the knowledge is spread. The patent owner can either commercialize his product or process on his own or licenses the technology to someone else, who in their turn can commercialize it. Patents are also beneficial from an informational point of view. A prize system should not be used when the government does not know the value of an invention or the costs of research. The income of patents, on the other hand, is determined by the market and dependant on demand and marketing efforts. Patents encourage inventors to keep the costs of invention low. Some negative aspects of patents compared to the other instruments are that they do not encourage inventions beneficial to the public good more than any other inventions, they have exclusionary effects, and create deadweight loss.[281]

Public funding is generally used to finance basic research. Since the adoption of the Bayh-Dole Act, which allows universities to patent their results of publically-funded research, and similar legislations in many European countries[282], there is a risk that less basic research ends up in the public domain. The legislation on academic patenting has provided incentives to the universities to turn their basic research, except when it in exceptional cases can be patented in itself, into patentable applications.[283]

Public funding is, besides for basic research, needed for research where the expenses and risks are so high that few are willing to take them, for example military hardware or agricultural research. Patents are generally more suitable to encourage those who pursue deviant ideas. Patents have the ability to encourage variety and new and non-expected ideas, where much of the public funding fails.[284]

The benefits of other forms of incentives than patents have resulted in a relatively low number of articles in economic journals. Shavell and van Ypersele have studied the benefits and costs of rewards, such as prizes, compared to patents. They found that patents were not more beneficial to society than rewards and that an optimal reward system would hold a possibility to choose between the two. Their conclusion was based on the facts that rewards in comparison to patents do not involve the granting of a monopoly power and deadweight loss could therefore be avoided, but that the social value of the invention and thereby the size of the rewards would be difficult to determine.[285]

[281] Guellec and van Pottelsberghe de la Potterie, 2007, pp. 57-63.
[282] Ibid, pp. 184-185.
[283] Kirshenbaum, 2002, pp. 1025-1027.
[284] Kaufer, 1989, pp. 45-47.
[285] Shavell and van Ypersele, 2001, pp. 525-526.

4.4 Optimal patent design

When assessing patent quality from a legal perspective, technical quality and legal certainty are emphasized. From an economic perspective, both these criteria are considered as well. Legal uncertainty and poor technical quality can have adverse effects on competition and make investments risky. Compared to the legal perspective, the economic approach goes further and emphasizes the objectives of the patent system. Even though a patent is in accordance with the law regarding legal certainty and technical quality, it might be of insufficient quality from an economic perspective, not encouraging innovation or the diffusion thereof. The situation on the market might call for a higher inventive step for example. The granting of a patent should be based on whether the benefits of society are greater than the costs. Among the benefits, we find increased profits for the inventors which lead to increased incentives to invent, improved disclosure and trading with inventions made easier. Among the detriments, we find for example reduced competition which causes deadweight loss, blockage of knowledge which constitutes an obstacle to sequential innovation and results in a reduced pace of technological progress.[286]

From an economic perspective it is of interest to reflect over whether or not the invention would have become a reality if the prospect of a patent was non-existing. By considering the following criteria the question is more easily answered: costs of inventing a certain product, how risky it was, if there are other effective ways of appropriating the returns (e.g. secrecy, lead time advantages etc.) and if it could have been the subject of publically funded research. Secondly, one should take into account what an effect a patent would have on the diffusion of a new product. Is it a product which has no substitutes and would lead to great deadweight loss and pose an obstacle to sequential innovation if patented? Would a patent encourage commercialization of the product? If a company lacks manufacturing capabilities of their own, a patent would have positive effects on diffusion. Would the patent be disclosed at all if it is not patented? In general, product inventions are more likely to be disclosed than process inventions.[287]

This two-step investigation would improve the quality of granted patents, but there lies a great obstacle in trying to transform these criteria into concrete guidelines for the patent offices and courts. Why would this be so difficult? Firstly, because encouraging innovation and at the same time diffusion can be conflicting. Strengthened rights of exclusivity for the patentee raises the incentives to invent, but reduces diffusion. On the other hand, increased disclosure would make it easier to invent around the patented product and reduce the profits of the patentee. Secondly, it would be very difficult to find answers on the different questions asked in the two-step model. The granting of a patent on those grounds would be highly speculative. On what grounds a patent can be patented has to be clear and

[286] Guellec and van Pottelsberghe de la Potterie, 2007, p. 155.
[287] Ibid, pp. 116-117.

predictable. Many firms base their decisions on whether they should invent or not on the prospect of receiving a patent.[288]

Detailed economic evaluations seem to be difficult to realize, but it does not mean that policy makers should not take economic concerns into consideration. Decisions, which are in accordance with patent policies, but not with concerns on innovation on a broader level, should be rejected. For example, patents which are applied for to build on a patent thicket should be rejected.[289] Today, the patent offices and the courts do not have a mandate to look at patents from an economic perspective. In the EPO's Guidelines to Examiners, for example, it is explicitly said that this cannot be done. "The EPO has not been vested with the task of taking into account the economic affects of the grant of patents in specific areas of technology and of restricting the field of patentable subject matter accordingly."[290]

4.4.1 Patent breadth and duration

Different theories on optimal patent design in terms of breadth and duration have been put forward. They all try to balance negative and positive effects of patents. Gilbert, Shapiro, Klemperer and Scotchmer are some of the most cited scholars in this field.

Gilbert and Shapiro investigate how an inventor could be awarded while at the same time maximizing social welfare. They suggest that a patent of infinite length and narrow breadth is socially optimal. When a patent is broad its monopoly position on the market becomes stronger; fewer substitutes are available. Therefore, broader patents generally impose larger costs on society in terms of deadweight loss. When the lifetime of a patent is increased, "there is a constant trade-off between additional reward to the patentee and the increment to deadweight loss."[291] Infinite length is therefore a more appropriate way to secure returns for the inventor since broader patents is more costly in terms of deadweight loss. [292]

Gilbert and Shapiro offer some critic to their own findings. Their results are based on an assumption that the underlying environment is stationary and predictable. They conclude that this assumption has no effect on a firm that is risk neutral. Firms that are risk averse would benefit more from broader and shorter patents. These companies are more dependent on profits made in the near future. Another limitation in Gilbert and Shapiro's findings is that they focus on a single innovation and do not take into consideration that innovation is cumulative. They suggest that patents with a longer duration could hamper future innovation and that the social costs would increase more than the profits for the patentee. The trade-off between deadweight

[288] Guellec and van Pottelsberghe de la Potterie, 2007, pp. 116-117.
[289] Ibid. pp. 117-118.
[290] EPO Guidelines to Examiners, part C, chapter 4, section 3.3a p. 49.
[291] Gilbert and Shapiro, 1990, p. 107.
[292] Ibid, pp. 106-108.

loss and the profits of the patentee would not remain constant. Gilbert and Shapiro suggest that more research has to be performed in this area.[293]

Klemperer published an article in the same year, also covering what kind of patent design that result in profits for the patentee with the least social costs. Klemperer identifies two different types of welfare losses caused by patents. The first one stems from when consumers buy other varieties of the patented product. These varieties are unpatented and can therefore be sold at competitive prices. The welfare loss lies in the fact that consumers can not afford to buy the product they would like due to monopoly pricing. The second type of welfare loss occurs when consumers refrain from buying in a certain product class all together due to higher prices. Broader patents reduce the number of choices for consumers within a product class and make it possible for a patentee to charge higher prices. This raises the second type of welfare loss in comparison to profits. When patents are infinitely broad and there is no competition at all within the product class, only the second kind of welfare loss can occur. If the fact that consumers should consume is of greatest concern to society then patents should be narrow. This would ensure lower prices and reduce the welfare losses associated with consumers not being able to buy the product of their initial choice. If society instead is more concerned with the welfare losses associated with substitution within product class then patents should be broad.[294] Patents should be narrow and infinite in length when all consumers have the same preference between the patented product and the substitute. Then the patentee can set a price so that no one would buy the substitute and since narrower patents pressure the patent holder to a lower price it would be the preferable way to reward innovators from a welfare perspective. Patents should be broad and short in length when consumers have the same reservation price, the maximum price consumers are willing to pay, for the product of their initial choice. This is most efficient since it eliminates deadweight loss caused by forcing consumers to settle with their second-best choice.[295]

The findings of Klemperer indicate that optimal patent design is different depending on the product class. Just like Gilbert and Shapiro he concludes that more research needs to be performed in the field of optimal patent design and sequential innovation. A broad patent could prevent duplicative research aimed at imitating already existing products. A narrow patent could create more incentives for an inventor to further develop his patented product. Narrow patents could also have a positive effect on R&D incentives, since narrower patents allow more room for several patentees within a delimited field. Klemperer finally highlights the importance of performing research on patent *height*, or leading breadth, more thoroughly.[296]

[293] Gilbert and Shapiro, 1990, p. 111-112.
[294] Klemperer, 1990, pp. 114-115, 126-127.
[295] Ibid. pp.120-121.
[296] Ibid. p. 127.

Scotchmer also argues that a "one size fits all" patent system is not optimal for different kinds of technologies. A patent system should be able to adjust the level of offered protection depending on how much protection is actually needed. Today some classes of technology are not rewarded sufficiently while others are rewarded too excessively compared to the cost of invention. The business method patent granted to amazon.com can be used as an example.[297] The patent was issued on their one-click method, which allows a user to make a purchase with one click on the mouse, without having to re-enter shipping and billing information. This patented technology is considered obvious and overrewarded by many.[298]

While Klemperer, Gilbert and Shapiro studied optimal patent design in static settings, Bessen and Maskin have studied optimal patent design in a sequential setting. Bessen and Maskin argue that patents function better as incentives for innovation in a static environment as compared to a sequential environment. The prospective profits of an inventor would possibly be even higher with competition and imitation. An imitation of a product recently patented would reduce the profits for the patentee from that product, but it could increase future profits with follow-on innovations. Bessen and Maskin use the US software industry as an example. In this industry, the firms with the highest patent propensity rates have reduced their investment in R&D in relation to sales.[299]

4.4.2 Aligning reward with contribution

Shapiro also argues that many patents are overrewarded. In comparison to Scotchmer, who considers reward in relation to cost of invention, Shapiro considers reward in relation to contribution to economic welfare. He argues that under the current US patent system many patentees make private rewards that go beyond their social contributions. The negative consequences of overrewarding are deadweight loss and lowered pace of technological progress. The deadweight loss is due to higher prices for consumers caused by increasing costs of royalties for technology users and increasing costs to avoid being sued for patent infringement. The lowered pace of technological progress is again due to higher costs for accessing technology and much more limited options.[300]

Excessive rewards are due to several factors, whereof the following constitute some of the most important. Firstly, patents are granted on technologies that should be considered obvious, Secondly, patents are granted on technologies that are not novel. Thirdly, many of the granted patents include overly broad claims that will cover future products. Lastly, patent holders of single features in complex products have additional bargaining power in royalty negotiations since they can threat with injunctions.[301]

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[297] US patent number 5,960,411.
[298] Scotchmer, 2004, p. 117.
[299] Bessen and Maskin, 2006, pp. 1-3, 34-35.
[300] Shapiro, 2007, p. 1.
[301] Ibid. p. 2.

When aligning the reward of inventors with their actual social contribution economic efficiency is promoted. Overrewarding and underrewarding reduce economic efficiency and hamper technological progress. Shaprio suggests two reforms of the patent system that would reduce excessive rewards. The first one is to establish an independent inventions defence and the second is to enhance the use of re-examinations. These kinds of reforms would not result in lowered rewards for *all* patentees irrespective of what line of business. Reducing patent length, for example, is a policy measure that would reduce patent rewards for all patentees. This is troubling since economic significance, costs and risks associated with different patents vary greatly between different industries. In addition, the suggested proposals do not presume that the patent offices and the courts have the capability of differing between inventions of varying benefits, costs and risk.[302] The proposals aim at promoting economic efficiency "regardless of the distribution of benefits, costs and risks across patented inventions."[303] In the short run, these proposals would improve efficiency ex post by reducing excessive rewards. In the long run, they would improve efficiency ex ante by influencing firms' decisions in R&D investments and patenting.[304]

An establishment of the independent defence would only be relevant for a reform of the US patent system since they rely on a first-to-invent system, as compared to a first-to-file system, used in Europe. In Europe it is possible to receive prior user rights if someone has invented and secretly used the product or process before someone else patented a similar product.[305]

The fact that two independent inventors would come up with the same invention at the same time is not uncommon today, especially in the industries of biotechnology and information technology. Consider, as an example, a situation where much of the underlying knowledge base is in the public domain and technological advancement is moving rapidly. Independent invention by two or more inventors is most likely to occur for patents which are close to being obvious. The benefits for these inventions are generally much higher than the cost of developing them.[306] An independent defence provision would not change the fact that the patent is given to the first inventor, but would make it possible for anyone who could prove that they have invented the same invention independently to freely use the patented technology. What are the beneficial economic effects of the proposal? Let us assume that A receives the patent on a product and that B has independently invented the same product. Letting B use the same technology freely creates a duopoly. A and B use the product competitively and the deadweight associated with patent monopolies are reduced. It should be made clear that the duopoly is not symmetric. A still has the right to license the invention to other as well as sue other potential infringers. In the long-

[302] Shapiro, 2007, pp. 3-4.
[303] Ibid, p. 4.
[304] Ibid. p. 4.
[305] Ibid. p. 4.
[306] Ibid. p. 8.

run, the proposal increases the incentives to invent. Under circumstances where neither A nor B know if they will be the first inventor, the proposal reduces transaction cost involved with licensing. It would also reduce the rewards to patents on obvious technologies and contribute to the breaking of the vicious cycles at the USPTO, described in section 3.1.1.1, which in turn would affect the patenting decisions by many firms. Finally, it would relieve the problem of patent hold-ups. One negative effect is that it could lead to an increased use of trade secrets and thus less diffusion, but these social costs have to be compared to the many benefits of the proposal.[307]

Enhanced re-examinations[308] are a way to prevent patents, which never should have been granted, to cause economic harm. Third parties should be allowed to request a re-examination of a patent at an early date, prefe-rably before agreements on licenses and users have made product specific investments. The re-examination should result in that a meaningful number of patents are invalidated or narrowed in scope.[309] This is important since "if some patents are weakened or invalidated by re-examination, others must be strengthened."[310] Enhanced re-examinations would be beneficial for several reasons. Firstly, they are less costly than patent litigation, which is another way to challenge a patent. Secondly, the presumption of validity does not have to be as high as in court. Thirdly, the excessive rewards given to holders of poor-quality patents can be reduced. Fourthly, they can alleviate the hold-up problem.[311]

Shapiro also highlights the problems with complementary innovation, which are similar to the problems with cumulative innovation. Complementary innovations are especially common in the information technology. Consider as an example the inventing of a faster microprocessor and the inventing of improved power management. These are two separate inventions, but together they can complement each other and improve the quality of lap top computers. The capabilities of the complementary inventions are greater when they are worked together than worked individually. Shapiro argues that if one of the complementary inventions is given too large awards it could reduce the availability of awards for the other invention. This would make it less probable that synergies occur and reduce innovation and economic efficiency in the long run. It is therefore desirable to offer policy solutions that divide available awards among inventors of complementary inventions. To avoid overrewarding and promote future innovations it is generally optimal if patent holders only appropriate the social contribution of their patents partially.[312]

[307] Shapiro, 2007, pp. 19-25.
[308] Patent re-examinations already exist in the US and in Europe, but the challengers do not have the right to participate as much as would be desirable. Ibid, p. 30.
[309] Ibid, pp. 29-31.
[310] Ibid, p. 31.
[311] Ibid, pp. 31-32.
[312] Ibid. pp. 14-17.

4.5 Analysis

This chapter have shown that the objectives of patents are compromised in several ways. The question is whether the objectives are compromised to such an extent that the benefits of patents no longer make up for the social costs they impose on society. The intent of the objectives of patents are undoubtedly good. In theory they make great sense, but their completeness when put into practice can be questioned. Innovative activity is a fundamental condition for a country's economic growth and international competitiveness. It is of great importance to have an incentive system that works well. We need patent systems with regulations that take social costs into consideration. This analysis begins with assessing how well the objectives of the patent system work and how they are socially beneficial. Thereafter the social costs are considered. This is followed by a discussion on optimal patent design.

4.5.1 Efficency of the patent objectives

How well do the objectives of patents work? As incentives for innovation, there is no empirical evidence on their effectiveness. The PACE and Carnegie Mellon surveys only study how important patents are to firms, but not how these firms would act if the option to patent was non-existent. The fact that no empirical studies on this matter exist is most likely due to the difficulty in producing accurate results. Today's firms are accustomed to being able to protect their inventions with patents. If firms, which patent extensively were asked what they would do if they could not protect their inventions with patents, they would most likely be inclined to answer that they would not be able to cover their investments in R&D and would therefor not invent. It is certainly probable that some firms would abandon some projects, but is it not likely that other firms would find new ways to cover their costs? The answer is probably quite dependant on what line of business they are engaged in. How well patents work as incentives today, is a mere estimation. For some firms, especially in the field of pharmacueticals and medical equipment they seem to be of great importance for their decisions to innovate. For other firms, especially minor firms, they rather seem to work as disincentives. Various side effects of the patent objectives, such as strategic patenting with patent thickets and strategic litigation keep some firms away from engaging in patenting. These side effects reduce the likeliness that firms can appropriate what they have invested in producing product or processes. The problem is that patents, the way they are being granted today, create incentives to patent too much in comparison to what would be more optimal.

How do patents work as incentives for diffusion? For those who recieve patents, it is not possible to avoid making their inventions public. So from this perspective it is working rather well. However, making an invention public does not mean that it ends up in the public domain; it is still a monopoly. Diffusion is suppose to facilitate for follow-up innovations and

substitutes, which it most likely does to a great extent, but follow-up innovations are compromised by patent thickets and licensing issues for cumulative innovation. Would diffusion be greater if patents did not exist at all and would there be any benefits? One could argue that this would decrease innovative activity, since others could imitate and commercialize innovator's product free of charge, or that this on the contrary would increase technological progress, like Bessen and Maskin argues. Most likely the answer on this question varies from industry to industry and dependant on how costly it is to produce new products. In industries where progress is rapid, like in the semi-conductor industry, the absence of patent protection could possibly increase technological process. Lastly, patents are suppose to facilitate trading with inventions. The fact that patents reduce transaction costs when trading with innovations is beyond dispute, but the fact that the boundaries of patents have become more unclear in recent years has also increased the transaction costs.

4.5.2 Costs and benefits of patents

The last couple of paragraphs have showed that the objectives of patents at least create *some* social benefits. Patents are benficial in the way that they, at least to some extent, create incentive to invest, create diffusion and facilitate trading with inventions. The fact that the objectives of patents do not create greater benefits does not to a large extent have to do with the objectives in themselves, rather the environment in which they work and how they are carried out.

The problematic aspects presented under section 5.2 form the social costs of patents. Similarly to why the objectives of patents were incapable of fulfilling and promoting greater benefits, most of the social costs are products of the current patent environment. Namely, the costs imposed by strategic patenting and patent litigation such as waste of resources, high entry barriers for new firms, lowered pace of technological progress, more limited competition, and prolonged negative effects of deadweight loss. A social cost caused by the problems concerning sequential innovation is, for example, reduced pace of technological progress when inhibited to improve existing inventions. This cost is a product of patents in general and not the current patent landscape in particular. However, the social costs of sequential innovation are worsened by recent developments. The costs imposed by monopolistic markets are not only related to the fields of patents nor the field of innovation, deadweight loss and decline in production efficiency would occur in any monopolistic market.

4.5.2.1 Solutions on patent design

Is the fact that the benefits of patents are compromised to such an extent reason enough to abolish patents all together? In the late 1950s, when the second patent controversy took place, Machlup, one of the first economist in knowledge economy, argued in the following way on this matter:

"*If one does not know if a system as a whole is good or bad, the safest policy conclusion is to muddle through – either with it, if one has long lived with it, or without it, if one has lived without it. If we did not have a patent system, it would be irresponsible, on the basis of our present knowledge of its economic consequences, to recommend instituting one. But since we have had a patent system for a long time, it would be irresponsible, on the basis of our present knowledge, to recommend abolishing it.*"[313]

It is not a solution to abolish patents all together. Too many firms have adjusted their ways of running their businesses on the ability to appropriate the returns of investments in R&D on patents. However, it is not an option to let the European and US patent systems continue to move in the direction towards more patents, stronger patent rights, and increased social costs. It would be easier to accept the increased social costs if they at were proof of increased innovative activity, but no such proof exists. Changes have to be made. How can we create patent systems that minimize costs and maximize benefits?

4.5.2.2 Inventive step

It has already been explained in this analysis that much of the problems with reduced benefits and higher costs lie in the recent developments of patents. A reduction of the number of patents granted would greatly benefit the patent systems. Much is about breaking the vicious cycles at the patent offices, where too many applications and shortage of time lead to low-quality patents, which in turn creates incentives for applications of trivial products and processes and consequently an even higher number of applications. The leading breadth or inventive step of patents has to be raised so that the quality of patents increases and creates disincentives for trivial innovations to burden the patent system. Higher quality patents would also reduce the social costs associated with the incentives to patent strategically. Patent thickets would be less likely, just as much of evergreening. This would open up better for cumulative innovation. A higher inventive step could also solve the problems with strategic litigation. Many of today's patent holders have not been certain of their patents' value until they have been tried and upheld in courts. If patents were of higher quality already when they are granted less firms would be inclined to challenge patents in court. Deadweight loss is the kind of cost that cannot be eliminated by changing the inventive step, or by making any other kind of changes. However, the negative effects of deadweight loss can be reduced if the number of patents is reduced, which a higher inventive step would do. A higher inventive step would most likely create social benefits greater than the social costs they impose, regardless of product class. The cost of reduced incentives to patent low-quality patents is a very low cost in comparison.

[313] Machlup, An economic review of the patent system, 1958. pp. 79-80.

4.5.2.3 Patent breadth and duration

If a higher inventive step could alleviate the social costs associated with the increased patenting activity, then the main issues of concern remaining are deadweight loss and sequential innovation - how should society provide a large enough incentive to invest in innovation, but at the same time promoting sequential innovation. Would changes in breadth and duration reduce the social costs of patents even more? Below various combinations of patent length and breadth and their effects on deadweight loss, sequential innovation and incentives to innovate are presented in table format.

	Deadweight loss (DL)	Sequential innovation	Incentives to innovate
Patent duration and breadth			
1. Long and broad	High. Broad patents lead to higher prices and lower production. Consumers might leave product class when there is little room for substitutes. Much lower trade-off with DL when patents are long and broad compared to long and narrow.	Broad patents reduce space for other inventors. Follow-on innovations will most likely infringe on previous patent. Prerequisites of sequential innovation are worsened by longer patent.	The large rewards available when both long and broad creates great incentive. On the other hand, many inventors will fear that their investments are in vain since it is likely to infringe on someone else's patent.
2. Long and narrow	Low. Patentee forced to a lower price when there are more substitutes available in the same product class. Trade-off with deadweight loss.	Narrow patents leave more room for similar innovations. Long duration has little importance when patent is narrow. Could be a waste of resources when research is similar.	Decent incentives. Greater chance of receiving a patent and appropriating the returns of investments, but the question is if a narrow patent can appropriate all the investments even though it is long.
3. Short and broad	Relatively high. Broad patents lead to higher prices and lower production. Consumers might leave product class when there is little room for substitutes. Lower DL than in 1, since the disruption on the market is shorter.	Broad patents reduce space for other inventors. Follow-on innovations will most likely infringe on previous patent. With a short patent these effects are very time-limited	A broad patent is a good incentive, but a short patent is a disincentive. The fact that the patent is broad gives an innovator a better chance of appropriating the returns of the investment. An inventor will fear that his investments have been in vain since it is easy to infringe on someone else's patent.
4. Short and narrow	Low. Patentee forced to lower price when there are more substitutes available in the same product class. Lower DL, than any other option since it is both a short and narrow disruption.	Narrow patents leave more room for similar innovations.	Poor incentives. It could be difficult for the inventor to appropriate the returns of his investments.

Let us begin by considering the results in the table without making any differentiation depending on product class. No option is optimal in terms of deadweight loss, sequential innovation, and incentives to innovate. It becomes a question of balancing the costs and benefits. Which costs can we accept since they create great benefits and which can we not? Option 1, with long duration and great breadth as well as option 4, with short duration and narrow breadth can be excluded as good options early on. The costs related to option 1 are greater in terms of deadweight loss, hindered sequential innovation than the benefits it provides in incentives to innovate. Option 1, on the other hand, impose low levels of deadweight loss and hindered sequential innovation, but imposes high costs on society by not giving innovators the incentive to invest in R&D. We are therefore left with option 2 and 3. These options are good for various reasons. The deadweight loss is low in 2 and high in 3 and 2 is quite beneficial for sequential innovation and 3 is not far behind considering that it is a patent with short duration. It is difficult to decide which option that works better as an incentive. None of them work optimally. After having considered these various options, a combination of 2 and 3 would probably balance the costs and benefits the best. A patent of medium breadth and medium length would impose relatively low deadweight loss since there would still be enough substitutes to keep prices relatively low. In terms of sequential innovation and incentives to innovate there will be space for other types of inventions and the incentives would be good. The patent design we have today is of medium length, but the granted patents are often a bit too broad.

If we instead decide to take into consideration that various products are of greater interest to society and cost more in R&D than other products, will the conclusion differ? Society, is for example, more interested in providing incentives to come up with new lifesaving drugs as compared less important inventions, such as, inventions relating to cat litter.[314] It is inefficient to have the same patent design on all products since they do not need the same incentives to be invented. For pharmaceutical products society could be willing to accept the higher costs associated with longer and broader patents to ensure large enough incentives to invest, but society has at the same time a great interest in rapid progress. From a patent perspective these interests collide. On the one hand patents should be broad and lengthy to encourage investments and on the other hand they should be narrow and short to encourage sequential innovation. However, the first invention is necessary for the producing of sequential innovations. Therefore the invention, which other innovations build on have to be rewarded accordingly. Unless there are other ways of financing these industries patents should remain fairly broad and long. For less important products the costs associated with a patent can be higher than the actual benefits they create. Some products should be granted shorter and less broad patents and some should not be granted monopolies at all. Monopolies are serious disruptions on the market and should only be tolerated when the benefits outweigh the costs.

[314] There are actually hundreds of US patents relating to cat litter. For example, US Pat. 5738040 – Ventilated Cat Litter Box or US Pat. 6022058 – Vibrating Cat Litter Scoop. Available at: www.google.com/patents

Inventions that do not qualify for patents could rely on lead time advantages to recoup their costs.

A patent system offering various breadths and lengths might be theoretically superior, but is inferior in terms of feasibility. Patent length can be legislated on, but it would be more difficult with various lengths. Neither patent breadth nor inventive step can be legislated on. It would be a practical impossibility to legislate on these matters. The assessment of inventive step and breadth is performed by the patent offices and the courts and leaves great room for subjectivity. The future development of inventive step and patent breadth is dependent on general policy decisions of these authorities.

Shapiro offers a different approach to patent reform. The reward to the patentee is not aligned with the contribution by using different patent lengths and breadths, instead he suggests enhanced re-examinations and improved independent defence. These suggestions would effectively reduce some of the side effects of patent thickets and incorrectly granted patents, but not align reward with contribution as effectively as different patent length and breadths would do. However, since that would be very difficult to realize, Shapiro's suggestion is well worth considering especially in combination with a higher inventive step and somewhat narrower patents in general.

4.5.3 Pareto efficiency, Kaldor Hicks efficiency and the Coase theorem

This section considers patents from the perspective of the Pareto criterion, Kaldor Hicks criterion and the Coase theorem. This theory and the two criteria were initially described in section 4.2 and 4.4.1.

4.5.3.1 Pareto efficiency and Kaldor Hicks efficiency

With patents in the market, it can never be an equilibrium and pareto optimal. The conditions for equilibriums were presented in section 4.2.1. Patents contribute to monopolistic markets, bear resemblance to public goods, involve informational asymmetry and lastly, firms with patented products do not internalize social costs when making production decisions. However, various patent designs can be more pareto efficient or less pareto efficient. The following paragraphs consider to what extent various changes of patent systems are more or less pareto efficient and Kaldor Hicks efficient. The changes are the once suggested and discussed previously in the analysis, namely, abolishing patents, higher inventive step, medium broad and lengthy patents, and patents differentiated in terms of breadth and length.

None of these changes would be very pareto efficient. All of them would make some people worse off than before. Remember that it is the individual's own estimation that determines if she is worse off than before or not. All of the above mentioned changes would reduce the ability for

some to patent their products and processes. Abolishing patents all together would of course make more people worse off than the other suggestions and therefore be the least pareto efficient change.

The Kaldor Hicks criteria are used to examine whether a situation at least hypothetically could be pareto optimal. Since a situation with patents never can be pareto optimal we can again just consider to what extent the Kaldor Hicks criteria can make a situation more or less pareto efficient. The first question we use to analyse each of the changes is: Are the benefits of a change greater than the costs? Higher inventive step, medium broad and lengthy patents, and patents of differentiated breadth and duration are all changes which create benefits greater than the costs, but abolishing patents all together would impose costs greater than benefits by reducing the incentives to invest in R&D. The second question which we should ask is: Are the benefits from a change large enough to hypothetically cover the cost and still leave a surplus in benefits? The changes, which were given a positive answer in question 1, should reasonably cover the costs hypothetically and still leave a surplus. The costs originate from the fact that the incentive to innovate is taken away or reduced for some innovators, but these costs are lower than the benefits the changes create, such as, reduced deadweight loss, improved conditions for sequential innovation and incentives to innovate quality products. This shows that all these changes fulfil the Kaldor Hicks criteria.

In the absence of patents, inventions would impose positive externalities on other people. An inventor may bear all the cost of an innovation, but everyone benefits. This gives people an incentive to free ride on innovative efforts of others. A competitive market can therefore not be expected to provide an efficient level of inventions. According to the Coase theorem resources will be used efficiently, regardless of how the law assigns rights, if transaction costs are zero. The transaction costs associated with innovations in the absence of patents are far from zero and the efficiency maximizing agreements can therefore not take place. Since transactions costs are not zero, society is dependant on how the rights of patents are assigned. According to the normative effect of the Coase theorem, rights and duties should be assigned as they would have been, if transaction costs did not exist and all welfare maximizing agreements were to come true. If transaction costs did not exist, an inventor should have been rewarded enough to cover his costs of innovation and some extra reward should be given to encourage him to continue inventing. In return the inventor would allow others to use his invention. In the world, with transaction costs, patents are granted to have this effect. This is similar to the normative effect of the Coase theorem, according to which the legal system should assign people the rights and duties that they would have had if all welfare maximizing agreements were to come true.

4.5.3.1.1 Efficiency theorems and globalisation of patents

In section 3.3.5 some issues of concern for developing countries were presented. The following paragraphs take these issues into consideration and

evaluates from an economical perspective if it is reasonable to enforce patent systems in developing countries.

The two efficiency theorems can be applied on this circumstance. First of all, enforcing patent systems in developing countries cannot be considered pareto efficient. Many people will be worse off than they were before. What about the Kaldor Hicks efficiency criteria? Will the gainers gain more than the losers lose? The benefits of extending patent protection to developing countries are foremost that those who wish to protect their inventions, both nationals and foreigners, will have the ability to do so. This *could* increase incentives for domestic innovation and TT. In section 3.3.5 domestic innovation and TT were discussed. Regarding domestic innovation, Kang and Seo argued that stronger IPRs do not increase the rate of innovation and that domestic innovation was dependent on other factors, such as, the level of economic development and industrial structure. They suggested that only countries with a GDP per capita over $9,000 gain from stronger patent protection. Assuming that these findings are correct, especially newly industrialized countries could benefit from patent protection, but most of the developing countries would not. Regarding TT, Mansfield suggests that IPRs are important if firms are to invest in R&D facilities in developing countries, but had less importance for other kinds of investments, for example, sales and distribution outlets and facilitates to manufacture components. Patents would also be beneficial by reducing transactions costs of conducting business in developing countries and create predictability.

On the cost side, we find high costs for establishing new authorities for enforcement and educating personnel and deadweight loss, the more traditional cost. In regards of creating incentives for innovation, the reasoning above showed that this is highly dependent on the level of development of countries. One of the greatest costs of introducing patent systems is the reduced access to drugs, since the possibilities for developing countries to copy drugs from developed countries become very limited. It was previously explained that only 5% of all pharmaceutical research is performed on diseases primarily afflicting people in developing countries. Would a well-functioning patent system in developed countries be a large enough incentive for pharmaceutical companies to redirect their investments? One large obstacle still remains and that is the fact that people of developing countries cannot pay as much for drugs as people of the developed world. The fact that prosperity and welfare, measured respectively in money and units of utility, does not always coincide becomes obvious when considering the example of access to drugs. The fact that pharmaceutical companies sell their products to the citizens in developed countries, who are willing to pay the highest price, is actually pareto efficient, but is not welfare maximizing. Limiting the possibility for developing countries to copy drugs would certainly increase the incentives of pharmaceutical companies in developed countries, but it is unrealistic to believe that patent systems in developing countries is a large enough incentive to redirect R&D investments to such a large extent that it will make a significant difference for people of developing countries. We must

turn to other solutions when it comes to creating incentives for investing in R&D on diseases of developing countries. This will take great cooperation between states and new ways of approaching the problem, but this is outside the scope of this thesis.

Returning to the question whether the benefits outweigh the costs, the answer is depending on the level of development. For newly industrialized countries such as China, the benefits would outweigh the costs. They have a large domestic industry and have reached a higher level of economic development in general with industrial and institutional structure. Developing countries that have not reached this level of economic development should be allowed a longer time to adapt to patent laws.

To a large extent, the patent systems which are enforced in developing countries are similar to patent systems in developed countries. It is the patent systems of developed countries that have become standard setting for developing countries. If it is taken into consideration what has been presented previously in this chapter, patent systems of developed countries are currently not working very well. Such a weakened non-obvious requirement as we find in the US and to some extent in Europe should not be passed on to other countries. The SPLT project, aiming at harmonizing patent laws to a greater extent with, for example, synchronized standards for patentability could have detrimental effects on innovation if the negative effects of current patent systems are not taken seriously into account.

4.5.4 Closing paragrahs

The first paragraphs of this section are devoted to emphasizing the importance of encouraging basic research and keeping it in the public domain. Dr. Marcus Storch, Chairman of the Board of the Nobel Foundation, stressed the importance of this in his opening address at the Nobel Prize Award Ceremony in 2007.

"This year's Nobel Prizes can also be viewed from another perspective: the respective roles of basic research and applied research in social progress. There is a general consensus that knowledge and science play a crucial role in both human and economic development. At the international level, one expression of this is an ambition to increase the share of our resources that are set aside for research and development... But this quantitative target must be complemented by deliberations on the quality and focus of these investments, including the proper balance between basic and applied research. In this context, there is a risk that in pursuing the ambition to achieve quick results in terms of competitiveness at the company level, we will not allow enough scope for independent, purely knowledge-seeking basic research. We must avoid the risk of, literally, developing better and better radio tubes, but missing the opportunity to invent the transistor."[315]

[315] Visit http://nobelprize.org/award_ceremonies/ceremony_sthlm/speeches/opening-2007.html for the speech in full length.

The fact that the boundaries between basic and applied research have become vaguer within certain fields in combination with an interest to make commercial returns on basic research can have serious impact on future innovation. Even though Heller and Eisenberg's theory on the anti-commons can seem exaggerated, the problem should be taken seriously. Walsh et al. counter argue that the patenting of research tools are not a problem since companies have found ways to work around these patents through a combination of licensing, inventing around, infringement, using tools which are in the public domain and question validity in court. Even though companies have found these ways, one wonders if it should have to be this difficult to access research tools. Question validity in courts could be very costly and if the second-generation inventor is not sure that the invention he would like to use the research tool for will be a success, who would be willing to involve in a lawsuit? One also wonders if it is wise to encourage infringement, which clearly goes against the objectives of the patent systems. However, the suggestion by Walsh et. Al that patent laws should contain improved research exemptions is good. In the final paragraph we leave the issue of basic research behind and consider the choices made by firms in general.

Business will always be business. As mentioned in section 4.1, firms make their choices based on what is the best way to make profits. We cannot expect that firms will refrain from a good business deal to lower social costs. The choice not to patent products which could have been patented must be the choice of the firms themselves, but society can help businesses to make better choices by at least making the inventive step higher. If no measures are taken to change the direction that patents are heading, the future for innovative activity will be less promising. Imagine the sizes of the current backlogs at the EPO and the USPTO and the fact that they are growing for each year that passes. They create an enormous inventive hold-up.

5 Concluding comments

The patent landscape is of a very complex nature. At the same time as patents are becoming more and more complicated from an economic perspective with increased number of patents and strategic patenting, patent systems are expanding globally in a rapid pace. With this development, the future of patents holds many challenges. Policy makers would benefit from being familiar with the historical development of patents. Putting current developments in the context of past developments can provide an understanding that makes it easier to suggest future changes. Policy makers would also benefit greatly from taking into consideration the economics of patents. What is someone's benefit is often someone else's cost.

Patents have, beginning with Edison and Siemens and at an increasing pace more recently, been given a function as business strategies. The proper function of patents as incentives for innovation, diffusion and trading will soon be overshadowed by the function of patents as business strategies if changes are not made. It is positive that the EPO seems committed to breaking the vicious cycle of low-quality patents, but it is important that the US catches on to this trend as well. Patents are currently working in favour of those who already have patent protection and the current patent systems are strengthening already existing monopolies. The future development of patents must better take into consideration the interests of smaller and medium sized companies as well as the interests of developing countries.

The costs of the current patent systems come very close to being greater than the benefits they create. This thesis has suggested that many of the costs associated with the patent systems of today depends more on how it is worked today, then the inherent conflict of patents. A higher inventive step is critical for the future development of patent systems. This would break the vicious cycles at the patent offices and have positive effects on patent thickets and strategic litigation. Patents would be accompanied with a greater value than before. Regarding various breadths on patents, it has been discussed that it is difficult to enforce them since they cannot be legislated on. However, it would be beneficial to society if the breadth on patents in general was narrowed to some extent. Even though it is practically difficult to have various breadths, and even various lengths, on different products, such a suggestion holds many benefits from a cost-benefit perspective and should not be ruled out as an option. Various lengths would be less difficult to enforce than various breadths, since length is not dependent on a subjective assessment as compared to breadth. It would be desirable if more research with an emphasis on practical enforceability was performed in this field.

Whether it is reasonable or not to extend patent protection to developing countries have been considered from the perspective of history and economy. This thesis has shown that the historical argument and the

economic argument coincide. Patents are beneficial to a country when it has reached a level of economic development where they have built up inventive capacity within the country. It is reasonable to let the extension of patent protection to developing countries differentiate between countries and let it take longer time. Before agreeing on continued harmonization with the patent laws of today as the basis, current patent standards have to be evaluated thoroughly.

It is interesting that patents, so many centuries after its first entry into history, are still being questioned as the proper way to encourage innovation. The contestation of patents in general will most likely not be settled in the near future. At the same time, it must be considered sound that patents as an institution are being questioned continuously. Patents are not a perfect solution to encouraging innovation, but there is yet no better option. For the future we must keep in mind that increased innovation, and not increased patenting is the key for continued economic prosperity, at least in Europe and the US. Only a well-balanced patent system can create such effects.

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