NTNU – Trondheim
Norwegian University of
Science and Technology

Intellectual property and scientific research

A study of the interaction between IPR and research

Stig-Ole Berg Tøgersen

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Supervisor: Bjørn Otto Elvenes, IØT

Norwegian University of Science and Technology
Department of Industrial Economics and Technology Management

Assignment

In this study the author wants to focus on intellectual property rights and scientific research. The paper will be an empirical research on what degree intellectual property rights affects or influences researchers and scientists in their research. The purpose is to get a better understanding of how IPR influences the researchers' choice of problem statement, research approach, and publication. The author will look at research at technical management related research.

Abstract

The impact of intellectual property rights on innovation has been a fundamental concern of law- and policymakers, scholars, and researchers in both public and private institutions. In this thesis, I scrutinize the intellectual property rights debate regarding researchers, public and private institutions, open science, and innovation, and then address a set of correlated questions regarding IPR's affect and influence on national researchers regarding innovation in (1) their choice of research area and research approach; (2) communication and access to state of the art technology; (3) future research; and (4) disclosure.

Norwegian national institutes will be the foundation for my research. To address the questions I create an online survey that will be used to find trends among the researchers, and augment the survey results with interviews to get a deeper understanding behind the reasons for these trends.

I find that Norwegian national researchers are affected by IPR, whether it is consciously or unconsciously, but not in a manner that hinders innovation and research in a great amount.

Sammendrag (Norwegian)

Innflytelsen immaterielle rettigheter har på innovasjon har vært en fundamental bekymring for lov- og politikkmakere, akademikere, og forskere i både privat og offentlig sektor. I denne masteroppgaven gransker jeg den immaterielle rettighetsdebatten angående forskere, offentlig og private institusjoner, åpen forskning, og innovasjon, for så å svare på ett sett med harmonerte spørsmål angående immaterielle rettigheters innflytelse og påvirkning på nasjonale forskere angående innovasjon i (1) deres valg av forskningsområde og -tilnærmelse; (2) kommunikasjon og adgang til *"state of the art"* teknologi; (3) fremtidig forskning; (4) og offentligjøring.

Norske nasjonale institutt vil være fundamentet for min forskning. Til å svare på spørsmålene har jeg kreert en nettbasert spørreundersøkelse som vil bli brukt til å finne tendenser blant forskerne, og til å forsterke resultatene i undersøkelsen gjør jeg intervjuer for å få en dypere forståelse for grunnene til disse trendene.

Jeg erfarer at Norske nasjonale forskere blir påvirket av immaterielle rettigheter, om det er bevisst eller ubevisst, men ikke på en måte som hindrer innovasjon i en større grad.

Acknowledgement

With the delivery of this master thesis begins a new chapter in my life. The years and effort that has gone to be where I am at this point has been adventure, an adventure that has seen its challenges and excitement. Now I am at the end of this wonderful journey, which would not have been possible without the passionate and continued support from advisors, friends, and family.

First, I would like to express my deepest gratitude to Professor Bjørn Otto Elvenes, my main advisor and supervisor. Over the past year he has been my mentor and pillar in a demanding and fast paced field of study, guiding me wisely through the challenges and opportunities that I have faced. He has been most patient and fair, and for all that, I will always be grateful.

My family, Berit Berg and Siri Berg Trujillo, has supported me in so many indescribable ways to allow me to concentrate on the important elements of my life, and they have always had a voice of comfort and given precious support when it was needed.

Last but not least, I would express my gratitude to all the professors, scientists, and researchers for taking the time to help me with my master thesis. Had it not been for their responses, time, flexibility, and efforts the completion of this master thesis would not be possible.

In dedication to my grandmother, Solveig Tøgersen - you are dearly missed.

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Chapter 1: Introduction

1.1 Motivation

Intellectual property (IP) is an integral part of a globalized business industry, and more companies are dedicating additional attention and effort towards intellectual property rights (IPR). However, the IP-system has gotten a lot of bad press in the media lately because of numerous court battles regarding patents and other infringements. Many are starting to doubt the value of IP-systems, especially as a foundation for knowledge development, innovation, and creation.

Consequently, IPR has come under extreme scrutiny by law and policymakers. Companies, inventors, and researchers (and scientists)[1] have probably never been fighting more vigorously over ownership of idea then they are at present if measured in negotiations, lawsuits, and trials.

Internationally, the courts have become the new forum for companies to do business, which is litigating against each other for ownership of ideas and for infringement on intellectual property rights. Motorola alone was in

[1] Researchers and scientists will in this paper be treated as synonyms
[2] First cited in MURRAY, F. & STERN, S. 2005. Do formal intellectual Property Rights

twenty two court disputes over intellectual property from October 2010 to August 2011 (Lowensohn, 2011), and there are probably many more litigations that didn't go to trial. This indicates that the value of IPR is not only in its incentive, but can also be a valuable tool to gain competitive advantage, for example, to exclude competitors from valuable areas.

IPR is at a pivotal point. Governments are acknowledging that the situation has gotten out of control and that IPR might be threatening global innovation and trade routes between countries. They seek to create clearer guidelines, laws, and more governmental control and insight to calm the industry. New laws are starting to emerge to quiet the chaos and produce some stability within the industry regarding IP. The United States (US), for example, passed a "First to File" bill in 2011 (previously First to Invent), which was a gigantic change in their IP(R) laws (Wyatt, 2011).

However, governments are under immense pressure from the parties who gain advantage from the current IPR system, not only to keep the current system intact but also to make sure that future IPR is stronger and more forcefully enforced.

National institutes are trending towards using IPR increasingly to gain much needed capital to cover expenses, although many feel that universities should remain an open science community. The ramification of

increased use of IPR might not only be economical and political, but can stretch to ethical and cultural difficulties about the role of national state (public) sponsored research.

The argument for IPR is that granting sovereign rights to a product or a physical manifestation of an idea to inventors for a period of time stimulates innovation. Paradoxically, the same argument might be the reason that inhibits innovation. Some authors write that current IPR incentives pay more attention on how to exclude others, which is the opposite of its intent, i.e., to boost innovation in the long term (Nelson, 1959, Levin et al., 1987, Arrow, 1962, Kremer, 1997, Scotchmer, 1996)[2]. Bill Gates wrote,

"If people had understood how patents would be granted when most of today's ideas were invented, and had taken out patents, the industry would be at a complete standstill." (Gates, 1991).

Thus, the concern about IP-systems isn't solemnly confided to politicians but also to business people and the private industry. Some of the negative aspects of IPR have especially become evident during the later years of globalization.

[2] First cited in MURRAY, F. & STERN, S. 2005. Do formal intellectual Property Rights Hinder Free Flow of Scientific Knowledge? An empirical Test of the anti-Commons Hypothesis, . *NBER Working paper, 11465*.

Globalization has obviously made it easier to share and copy information. However, the current IP-law regime is mostly based on national laws, but reforms in the laws and collaboration between countries are starting to facilitate and support trade across borders[3]. If governments are to use laws as a tool to stabilize the market, then emerging laws should not be based on perception or qualified guesses, but they should be grounded in scientific research to ensure that such laws have the maximum probability of success.

1.1.1 Report objective

The objective of this thesis is not to lecture which direction new IP-laws should focus on nor express any opinions on lawmaking. The objective is to discover how the current IPR system is affecting researchers, and help to build a repertoire of knowledge on this subject.

The author will focus on IRP and scientific research, especially researchers. The paper will be an empirical research based on the effects of IPR, and if IPR affects or influence Norwegian national researchers in technical management in their research journey to innovation. The study's purpose is to gain more knowledge and understanding about the synergy

[3] The TRIPS agreement: WTO. n.d. *Understanding the WTO: The Agreements, Intellectual property: protection and enforcements* [Online]. Available: http://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm7_e.htm [Accessed 23.05 2012].

between the balance of protecting innovations and the distribution of protections to those who innovate. Important questions beg to be answered: Does IPR affect or influence national[4] researchers regarding innovation in (1) their choice of research area and research approach; (2) communication and access to state of the art technology; (3) future research; (4) and disclosure?

Hopefully, answers to these critical questions will give further knowledge into how well our current IPR system is working, and hopefully those answers can facilitate policymakers in future decisions.

1.2 Significance of report topic

The emphasis of this thesis is on the relationship between national researchers and intellectual property rights. This is an important relationship because some argue that applied research cannot exist without basic research (more on that in chapter 2.3). For many centuries basic research has been based on open science and free flow of information, relying on peer review as a cornerstone to confirm science.

If new knowledge and technology becomes too protected without the ability for peers to review and confirm it on an independent basis, to what

[4] The terms national researcher and public researcher will be associated with researchers working at national institutes.

extent can results be certified as scientifically significant. Meanwhile universities are corporatizing their structure to fit a global economy in which intellectual property is leading the way.

In 1995, the book value of the Standard & Poor index of 500 companies accounted for only 26 percent of the market value whilst intangible assets were worth three times more (Perelman, 2003). An study done by Ned Davies research (2011) concluded that intangible assets covered 79.7 percent of all assets in the 500 largest companies in the US. Income through patent licenses grew from 15 billion US dollars in 1990 to more than 110 billion US dollars in 1999 (Bader, 2006). Athreye and Cantwell (2005) has estimated that the commercialization volume of intellectual property has grown to roughly 100 billion US dollars.

Obviously, it is the obligation of a firm to maximize their stakeholders return on investments, within legal and ethical boundaries, and that includes investment in IP and the use of IPR. However, national states, which are granting and facilitating the use of IPR, desire full disclosure of idea in return. This creates a dynamic field of conflicting interests among national and international government agencies, a field that they are trying to balance for the greater good of society.

The Norwegian government has issued a demand for a report on intellectual property rights. The goal is to contribute to an increased understanding of intellectual property (rights) and to develop a futuristic policy on the area. The minister of Trade and Industry in Norway, Trond Giske, stressed the importance of the relationship between researchers and intellectual property rights:

"To all who works with research, innovation, and commerce development, the need for adequate capability and attention around intellectual property is increasing. This is to secure ownership of one's own valuables and innovations, to exploit current knowledge, and to avoid infringements on the privileges of others" [5] (*Norwegian Government, 2011)*

Norwegian researchers are following the government's exposition and await new IPR reforms and laws. Morten Wallø Tvedt, lawyer and senior researcher, wrote a comment to the newspaper "Dagsavisen.no" outlining that he believes the government wants to invest in biotechnology, but that there is need for a new IP-laws:

"Their opinion is that increased patenting (within universities) is a good thing, without basing their opinion on empirical research"[6] *(Tvedt, 2012)*

[5] The author has translated the statement to English to the best of his ability to convey a precise picture of its meaning.
[6] The author has translated the statement to English to the best of his ability to convey a precise picture of its meaning

1.3 Thesis overview and structure

The intent of this thesis is to be a probing study for law and policymakers as well as preliminary study to anyone who wants a brief introduction to the subject before embarking on an examination on a grander scale. Its aim is to use a methodical approach using literature, history, archives, interviews, and surveys in a semiquantitative and qualitative framework to triangulate[7] and create as strong a fundament for evidence as possible.

In ***Chapter 2*** the author conveys existing literature on the subject in question. It starts with a summary on literature regarding IPR and open science, followed by a summary on literature on the synergy between IPR; national research institutes; and private companies, and ends with a discussion based on literature regarding IPR and its effect on researchers.

Chapter 3 describes the methodology of this thesis. First there will be a discussion on choice of method with pros and cons. This then leads to how the thesis was conducted regarding subject, data, form, analysis, and validity.

This is followed by ***Chapter 4***, which conveys the results and the discussion parts of the thesis. This chapter is divided into five categories: research, access to technology, future research and communication,

[7] This is a method that uses multiple sources of evidence.

disclosure, and researchers' comments on IPR. The first four is linked to a survey and interviews and describes in detail in those particular areas, while the last category is dedicated to comments from the interviews that were conducted.

In ***Chapter 5*** the author reviews the thesis and concludes on the findings before recognizing its limitation and commenting on potential areas for future research.

Chapter 2: Intellectual Property Rights debates

2.1 IPR and open science

IPR is a tool used by the governments to enable innovators to harvest a reward in exchange for disclosing their ideas through descriptive and detailed plans. The general idea is that IPR will give incentive to researchers and investors to devote time, effort, and money to work on innovations and then share their ideas with society. In return, creators get a monopoly or some other form of protection for their idea for a limited time span.

The purpose is to maximize economic growth while balancing the social costs to a manageable level, and at the same time build a pool of knowledge and ideas that other researchers and scientist can make use of to take greater and faster strides in innovation. To let companies protect their investments while, hopefully, most innovation becomes available to the public, which could increase the quality of life (Kalanje, n.d.).

The balancing act is a great challenge, and there is much debate on to what degree a company should be allowed to protect its investment contra how

much and how rapid they should share its innovation with society, i.e., what protection should be allowed and how strong should this protection be.

To minimize a potential minefield most national states doesn't regard scientific discoveries, for example: scientific principles, algorithms, mental processes, movements, and so on, as innovations because most societies want this information to be as open and accessible as possible.

Additionally, a more severe issue regarding open science is that of the right to protection and who should have the right to protect when the innovator(s) are funded fully or mainly by tax payer money. Intuitively, it is the inhabitants and private companies that are paying for such research through taxes, and based on a general IPR principle – the investor gets ownership – then such research should be made open for the society.

Some authors cast doubt on the effectiveness of IPR to deliver the desired outcome as intended (Chang, 2001, Boldrin and Levine, 2002, Popov, 2011)[8]. Increased use of IPR among the industry and stronger IPR given by governments has spawned a vigorous debate among academics and politicians over what is known as the "anti-commons effect". The anti-

[8] Some authors represented in the literature section have used patents as a foundation for their methodology. However, some caution should be asserted to this methodology and its limitations. See Huang (2006), chapter 5.3.

commons effect is best described when first considering “the commons”, which is the opposite of the anti-commons.

The commons is some sort of wealth that belongs to us all (On the commons, 2012). It is resources that are free to use and owned by people that wants to take part of it. The commons effect relate to the overuse of limited common resources, like fish; whales; oil; air; and etc., to a point where the earth’s common resources are being depleted due to the fact that there is no definite owner of the property who can control and dictates its usage.

The anti-commons effect is a term used for commodities that are in a limited availability and where there are too many owners that are unwilling to share, i.e., owners excludes each other and others (Heller, 1998), which arguably sets society in a poorer standing due to the desire of personal gain. The theory of the anti-common tells us that researchers can exclude their work from lechers and copy-cats who don’t want to put in the effort needed to innovate something of their own, but at the same time postulates that the use of IPR in areas traditionally reserved for public commons can halt cumulative scientific discovery (Heller, 1998, Heller and Eisenberg, 1998, David, 2003, Etzkowitz, 1998).

Murray and Stern (2005, p.31) were in their studies able to

"Reject the null hypothesis that IP rights have no impact on the diffusion of scientific knowledge"

and also noted that the anti-commons effect is most significant for universities and other institutes sponsored by public funding.

The debate centers on whether or not expansion of IPR is limiting the benefits from scientific progress by making such resources private instead of having an open science policy (Heller and Eisenberg, 1998, Argyres and Liebeskind, 1998, David, 2001)[9].

An example of such, which would have crippled the internet for the common people, would have been the privatization of the TCP protocol. TCP is a tool that makes it possible for people to use the internet and plug-in application as we know it, and it is generally agreed among academic that if the protocol had been patented, the spread of internet would not been as fast (Popov, 2011).

Most national states has a clause build into their IP-systems that asserts that if some innovation is considered to be of national interest, then the state has the right to make that innovation public. However, that clause is

[9] As cited in MURRAY, F. & STERN, S. 2005. Do formal intellectual Property Rights Hinder Free Flow of Scientific Knowledge? An empirical Test of the anti-Commons Hypothesis, . *NBER Working paper, 11465*.

seldom used, and if used, could generate long-lasting and costly legal battles.

Studies have shown that IPR does more economic harm than good, and that patent reform laws might not be enough to save IPR (Boldrin and Levine, 2002, Sakakibara and Bransletter, 2001). However, some argue that IPR might give life to competition and multiple solutions to problems because other research paths must be taken to solve a problem due to the protection of one solution, which ultimately leads to more innovation and less duplication (Mazzoleni and Nelson, 1998).

Still, the ability to use previously discovered results would be time saving, even though it might lead science in a monotonic direction. One of the greatest minds in our time, Sir Isaac Newton, recognized open science in a letter sent to Robert Hooke:

"If I have seen a little further it is by standing on the shoulders of Giants."

acknowledging that he wouldn't progressed as far without the help from others (Mulder, n.d.).

Etzkowitz (1998) and Murray and Stern (2005) came to the conclusion that IPR might inhibit the ability of researchers to build on each other's works since knowledge wouldn't be free flowing. This notion is somewhat

backed up by Lerner (2002, p.27) who believes that patent protection doesn't lead to more innovation:

"Adjusting for the change in overall patenting, the impact of patent protection-enhancing shifts on applications by residents was actually negative, whether filings in Great Britain or domestically were considered."

The open science system has what some will call a flaw; its incentive system. The community is built on recognition and reputation for those who are first to invent or publish. However, some kind of capital in the likes of money, equipment, and facilities must be invested to give life to research projects. Investors, or any other, will seldom give coin away without getting something in return, usually in greater numbers or quanta.

It has generally been accepted for some time that free competition and a free market system on their own aren't enough to create adequate incentives for innovation as argued by Nelson (1959) and Arrow (1962).

However, there are many examples of success with open innovation. Google's Android OS and Linux OS are based on an open source code OS and both are openly distributed. Both companies are reaping the benefits on a commercial scale. Although not as direct sales revenues, but as an

effect of their trademark, their reputation, and their ability to sell add-on products, which again might evolve around IPR.

Geiger (2010) stated that there are an increasing number of firms that embrace the open science philosophy, and empirical research advocate that an open science system between public institutions and private companies is favorable for both parts (Cockburn and Henderson, 1998).

Open system or not, over ninety percent off all information in patents are not protected due to expiration, rejection, retraction or non-extension and are free to use for whomever who wants to use them (Ehrat, 1997)[10]. All this information might arguably be enough for researchers to create innovation.

Some might argue that the most pioneering information and the foremost state of the art technology are the ones that are currently under IPR protection (and under the protection of trade secrets[11]). Other facts states that around eighty percent of technical information in patents application is published (Bader, 2006), which would deem that most information and results are accessible and free to use.

[10] As cited in BADER, M. A. 2006. *Intellectual Property Management in R&D Collaborations: the case of the service Industry Sector*, Heidelberg, Physica-verlag.
[11] The author wants punctuate that trade secrets are not an IPR.

However, even though a requirement of patents is to contain all necessary knowledge and information to be replicated (so-called naked patents), many patent licensing contracts must contain additional necessities such that the patent becomes usable, which indicates that a naked patents alone might not be enough.

According to Baecker (2007) there is reason to believe that an increase in the number of patents was inevitably even without legal reforms strengthening the patent system due to, among others, international competition, increased government R&D spending, and technological opportunities. The legal reform did not stimulate new innovation, but rather reinforced existing incentives and tendencies (Jaffe, 1999).

Although, regarding the US patent war, some say that it was the US patent office that folded (because of such a high number of patent applications) and left it up to the courts to decide a patent's faith. Others, like Lemley (2001), believes that this is was a rational choice of the US patent office because of the cost to society and the tiny amount of patents that ever face litigation between companies and patent owners.

In the US only 1.5 percent of all patents are ever litigated between companies, and only 0.1 percent of those litigated went to trial (Lemley,

2001, Lanjouw and Schankerman, 2001).[12] This number is likely higher for European companies because litigation is less costly in the European legal system than in the US legal system.

The European Patent Office (EPO) have observed occurrences of opposition[13] in 7.9 percent of all patent applications that were granted, and 31.7 percent of the decisions in these cases were appealed (Peeters and Potterie, 2006).

The cost of litigation in the US legal system is also an argument against the potential policy of the US patent office to let the courts decide, because it favors the big and rich companies who have the means to participate in such endeavors.

2.2 IPR, national research institutes, and private companies

The role of IPR as a source of business for universities is believed to be on the rise. Spin-off companies and patent selling and licensing may become an important source of income. This can be a welcome prospect for both universities and government policymakers, in an era when governments

[12] As cited in BAECKER, P. 2007. *Real Options and intellectual Property: Capital Budgeting Under Imperfect Patent Protection,* Heidelberg, Springer-Verlag.
[13] Any third party has the ability to object to a patent granting decision made by the EPO.

budgets are squeezed, especially so in higher education (The European Commission, 2003).

Collaboration between university researchers and private companies can yield much benefit for both parties. University researchers get access to funds, ideas, and expertize, while private companies can benefit from the university networks and the scientific knowledge they produce (Hall et al., 2000, Link and Scott, 2005, Veugelers and Cassiman, 2005).[14]

The emergence of the concept "innovation systems", which is an open network of organizations both interacting with each other and operating within the framework conditions that regulate their activities and interactions (Edquist, 2001), has put more emphasis on scientific flow between the public and private sector because researchers have the opportunity to organize and engage in technology transfer.

The interaction between researchers in the public sector and those in the private sector is particularly important because it may provide unique competitive advantages (Verspagen, 2006). Bader (2006) argues that the relationship between companies and universities is based on companies seeking radical changes in their innovations.

[14] First cited in OKAMURO, H. & NISHIMURA, J. 2012. Impact of university intellectual property policy on the performance of university-industry research collaboration. *Journal of Technology Transfer*.

To make this process of technology transfer as smoothly as possible, the universities have created technology transfer offices (TTOs). TTOs are centers of excellence within IPR. They are to serve as a tool to help the researchers and universities establish intellectual property rights on the intellectual properties that show value. Researchers don't have the capability, interest, nor the essential knowledge to execute the needed work in technology transfer. Another reason for TTOs is to shrink the workload of administration that researchers are faced with when they have an idea that is patentable, which gives, hopefully, the researchers more time to do research.

As universities and national research institutions alike are figuring out – public funding doesn't seem enough to cover all areas of research expenses. There is a trend among institutes to sell their expertise to the private industry through, for example, consulting. Another trend is technology transfer to the private market, for example through spin-off companies and patent licensing and selling. Hence, universities can be viewed as repositories for knowledge while IPR protect their physical manifestations of the knowledge (creations).

The European Commission (2003), which can be seen as an EU federal government, listed the collaboration between researchers in public and private sector as one of six priorities for European universities in the

future, and stated that the two main mechanisms for technology transfer are outsourcing of university IP and spin-up companies.

However, research shows that the payoffs from patent licensing are hugely varying between inventions that it can hardly be imagined that licensing is a stable source of income for universities.

"In the US context, half of all universities has less than 1 million US$ licensing income per year (which is a relatively small amount, even when compared to the budget of an average European university). Moreover, only a few patents are responsible for the majority share of licensing income, suggesting that this source of finance has important characteristics that are similar to a lottery." (Verspagen, 2006, p.629)

Findings suggest that universities aren't collecting a significant amount of capital through patent licensing. In a study done on one hundred fifty U.S. universities, only about fifteen universities made over 10 million US$ a year on licensing. For instance, at Columbia University, their top five patents in terms of licensing were responsible for 94 percent of gross total income (Verspagen, 2006), which indicate that all their patents, roughly subtracted their top five to top ten, could be released to the society with minimal impact to their revenues.

Both of those results imply that patents do not secure commercial success. However, a partial explanation for those results might be that universities are paid a one-time fee for transferring the property to a company and thereby no licensing fee would be accumulated.

Geiger (2010) notes that cutbacks in the R&D among private companies suggest that they are being forced to cooperate or hire universities to deliver basic research, which is ironic if universities are trending to more applied research. More than 70 percent of research outsourced by private companies to universities is basic in nature. However, basic research covers less than 5 percent of the total industry R&D (i.e., both basic and applied research) and universities harvests only 18 percent of those 5 percent (Geiger, 2010).

R.Z. Gussin, Former Vice President for Science and Technology at Johnson &Johnson, stated that:

"..technology has become so sophisticated, broad, and expensive that even the largest companies cannot afford to do it all themselves." (Leonard-Barton, 1995, p.135)

However, for spin-off companies or patent selling and licensing to work as a source of income the need to use IPR is great. This is an issue for universities, which historically is based on free flow of scientific

knowledge and creating open information and open results. In times when governments are strapped for capital it may be vital for public institutions to seek out new ways of obtaining money, IPR being one of them[15].

The net benefits of academic patenting are under scrutiny. Nelson (2004) argue that increased patenting will extinguish the free flow of scientific knowledge, thereby leading to less production in scientific knowledge.

One study concluded that IPR leads to less collaboration among firms in the same industry:

"which implies less knowledge production in the economy because complex R&D projects that demand a bundle of resources and different skills in order to be realized may not be conducted" (Czarnitzki et al., 2011, p.20).

The same report states that collaboration between private firms and universities are not affected because they do not compete in the same market. How technology transfer is affecting the relationship between universities and private companies is uncertain, but there is certainly an ethical boundary that may be pushed or overstepped regarding knowledge and information transfer in research collaborations between the two. If a university is contracted by a company to make or help with product

[15] Obviously universities have other means to garner capital. This thesis focuses on the IPR aspect.

development in a specific area that is in direct competition with a previously assignment from a rival company there might be implications. Even if the knowledge is not protected the resulting solution might infringe upon one another.

There seem to be a very delicate line regarding transfer of tacit knowledge from a previous research project to a future research project. Sintef, a Norwegian national institution, got into trouble in year 2000. The institution had used tacit knowledge gained from an earlier project to make a new product for a third party. They dismantled a product to see how it worked, and then build another product based on the tacit knowledge gained. The owner of the patent of the product studied by Sintef sued for infringement, and in 2009 he won in the Norwegian Supreme Court (Domstol.no, 2009).

A consequence in the innovation system and technology transfer can be related to the strategic behavior of universities. If new strategies focus on income through IPR, then universities may be incline to do research on areas that are, for example, easier to patent. Henderson et al., (1998) argue that applied research is susceptible to this strategy, and therefore universities would have incentive to move away from basic research, which doesn't deliver immediate value (Verspagen, 2006). Faculties within the universities may have incentive to operate more as a private company,

and, as a result, the synergy in the universities regarding an open science community and a system of free flow of scientific research would evaporate. Another fall out is that the collaboration between private companies and the universities may evaporate because there is a risk that they are or can become rivals.

Interestingly, Pray and Naseem (2005), who did research in the fields of Rice Genomics and Plant Transformation Technologies, concluded that, though, patenting would hamper innovation of an idea for some years and also increase the costs for other innovators to catch up, ultimately, the technological advancements due to corporate money far outweigh the few negatives of patenting within the underlying fields.

And yet some studies imply that there may be no correlation between patens and more R&D (Arora et al., 2003), but the use of patents as an indicator for scientific research has not yet been empirically founded.

2.3 IPR and effects on researchers

According to literature, applied research and basic research should not be mistaken for one another. Basic research focuses on questions of fundamental scientific interest while applied research focus on usefulness and applications (Stokes, 1997).

Basic research at its core is based on free flow of scientific knowledge and open science. Applied research, however, is based on privatization of information and closed networks, and is disclosed through IPR if disclosure were to take place.

If a shift from basic research to applied research were to occur, the researcher's problem statement, research area, and research approach may also be on the verge of a change. While problem statement traditionally has been formulated to get a wide range of possible outcome regarding free flow of scientific information, now, researchers may be formulating to only find a solution for a specific narrowed issue and to avoid using material that might get researchers in problem with IPR infringement.

However, many scholars believe that applied research is a branch of basic research, and as a result applied research cannot stand alone. The pillar of applied research is to take advantage of publicly available and accessible basic research, and use the information to produce innovation with practical and commerce value (David, 2003). If this argument were to be true, then applied research might stagnant in the future if there is a shift to more applied research among national institutes, because there is no certainty that the private industry will fill the void of basic research that is left by universities.

For example, a void would doubted be filled regarding research in national states defensive programs. Even if such research often bears fruits to the private industry. One example of this is how US military research is helping the car industry on fuel economy (Green, 2012)[16].

Stokes (1997) established a phenomena of duality, "dual knowledge", which revealed that one single discovery could concurrently possess both applied and basic characteristics. As a result, a physical manifestation of basic research could be protected to a more extended degree by IPR.

If policy shifts suggest that universities should gain more of their income through the private market, then universities might choose a path of dual knowledge or only applied knowledge, if possible, leading to less openness in the scientific community. Some evidence points to a decline in knowledge accumulation as measured by forward citations in a dual knowledge community (Murray and Stern, 2005).

IPR may force researchers to become more close minded for two reasons. First reason is the state of a competitive researcher:

"*when patents and their potential financial rewards are an important research aim, researchers may feel tempted to operate in a competitive*

[16] The article (source) gives other examples on how military research has helped the car industry.

mode, rather than the cooperative mode that characterizes the open culture of science." (Verspagen, 2006, p.616-617).

Second, there are certain guidelines of which to get a patent approved. One of these guidelines is that a patent might be rejected on the grounds that too much information is divulged to parties outside the privacy of the project. As a result, researchers must keep information to themselves or enclosed in the research project during ongoing research.

This last point has two possible implications. (1) The project itself is a private entity that may not have access to seek council from outside the project without going through legal documentation (or might not have access at all), which means that researchers cannot communicate on an open platform to explore the vast pool of knowledge that is available in the networks of the institutes. (2) There is a greater chance for duplicate research since research will be kept secret for a period of time and clouded by dense patent bushes. A risk is that free flow of scientific knowledge is hampered in the long run, since new research will not be built on state of the art technology.

However, research has suggested that the use of IPR does not lead to abandonment of research projects nor does it lead to substantially halts in research projects. The same report also concluded that patents doesn't

seem to be an influence on research choices or an influence on research protocols (National research council (US), 2006). Though, this research was solemnly confined to genomic and proteomic research.

Research shows that the opportunity to make a considerable amount of money from the commercialization of science has led some academics to neglect their teaching responsibilities, violate conflict of interest rules, withhold publication of their research results, and act strategically in many other ways that benefit them financially at the expense of others (Harman, 2007). Arrow (1962, p.618) thinks there is a clear incentive for moving to more applied research because, as he describes it:

"Basic research,..., is especially unlikely to be rewarded"

However, other research has concluded that researchers are more interested in publishing than patenting (Agrawal and Henderson, 2002).

Chapter 3: Research methodology

3.1 Discussion of research method of choice

The method of research in this thesis is a combination of qualitative and semiquantitative research performed in an exploratory framework.

There is a great debate whether qualitative or quantitative is the best way to use as a research method. Fred Kerlinger is quoted in Miles and Huberman's book *"Qualitative Data Analysis: An expanded sourcebook"* (1994):

"There's no such thing as a qualitative data. Everything is either 1 or 0."(p.40)

In the same book, D.T. Campbell responds to this with:

"All research ultimately has a qualitative grounding."(p.40)

Though there is no definite answer to what approach is the better one, certainly both have their strength and weaknesses. One cannot or should not regularly rely solely on one or the other, but sometimes, when applicable, use a combination to lay the best foundation for research and its outcome as one possibly can.

Typically, qualitative research involves words to explain its content while quantitative research uses numbers to attain and show results. Another major difference that is commonly held is that qualitative research is inductive and quantitative is deductive. Inductive reasoning involves taking a series of observations and expanding those into a general theory. Deductive, on the other hand, rely on starting out with a theory or a general statement and then confirm its premise.

The power of qualitative data is that it is

"*typically rich in details and context, interpretations are tied directly to the data source, and research validity and reliability are based upon the logic of the study interpretations rather than statistical tests*" (Libarkin and Kurdziel, 2002).

However, the attention to detail is also its demise because it can only be applied to a narrow range of circumstances, i.e., it fails to make connection to larger situations. Another downside is that the study is believed to be bias to some extent from the author himself as he can shape the results to a degree, consciously or unconsciously.

The quantitative research method is very well documented in the science community. There is a wide range of statistical methods that allows researchers to base their findings on several models that can account for a

certain phenomenon. There is also little bias from the researcher since the research is governed by statistics (Libarkin and Kurdziel, 2002), i.e., it is difficult to manipulate statistical results unconsciously. However, caution should be asserted because statistics can be consciously and easily be manipulated by the researcher. Though, a critical research that aims to duplicate the results might easily discover manipulation made by others.

The weaknesses of the quantitative approach is that it can have little correlation with a real life scenario and that it forces responses or subjects into categories that do not fit in order to make meaning. This last point is also a case when qualitative research uses constructs as, for example, a questionnaire as a tool.

Naturally, in this thesis, a mix between the qualitative and quantitative study fits the profile best as the purpose of this study was to do an exploratory study without a specific theory as its base (to confirm or disprove) but relies on numbers to get a starting point for its base.

The report was based on two philosophies of research method: quantitative and qualitative; the quantitative part being the survey and the qualitative part being the interviews. However, the survey can be more accurate describe as a semiquantitative approach since no statistical tools is deployed. The purpose of the survey was to find small but noteworthy

trends and patterns among the researchers. Kostoff (1993) describe the semiquantitative (SQ) method as a quantitative tool that make less or little use of mathematical tools but attempt to draw on results wherever possible.

The strength of using the SQ method rests on how easy and transparent the method is. It can be very intuitive, and the author as well as the reader should have no problem in assessing its results. The weakness is that this method uses no statistical tools to find correlation. The method has limited credibility in the analytic community towards analysis of data because the method isn't mathematically rigorous (Kostoff, 1993). The SQ approach approximate data, rather than provide an exact measurement, and that was exactly why this method would perfectly fit the author's research framework as a research approach since the author was searching for trends.

The interviews were the qualitative part of the study, aimed at finding more accurate and in-depth responses from the subject pool and to discover discrepancies in the answers from the survey. The last point is important because the interviews will hopefully show if the respondents understood the questions in the survey and that their answers reflect their comprehension of those questions.

The main methods of evidence collection in this paper were interviews and an online survey. The interviews was formed as focused interviews (Merton et al., 1990)[17]; they were open-ended and assumed a conversational manner that followed a set of questions derived on the basis of the results of the online survey. The pros of interviews are, among others, that they are rich in data and details. Additionally, there is an opportunity to probe for more explained answers and avoid misconceptions as well as the opportunity to do follow up questions based on necessity.

The cons are that the interviewer is biased or can do errors, as well as subjectivity among the interviewees. The author has tried to downsize the cons by (1) getting input from associates on the questions and the formulation of those questions and (2) pointing out subjectivity from the interviewees in the report where it was appropriate.

The online survey was formed as a multiple-choice questionnaire in a traditional manner (Gillham, 2000). The pros of an online survey is that it is easy to get information from a lot of people quickly, the analysis is straightforward, and that it can provide suggestive data for further research. The cons are the problem of getting quality data regarding completeness and accuracy, misunderstandings cannot be corrected, questionnaire development is usually poor, and question wording can have great effect

[17] As cited in YIN, R. K. 2009. *Case Study Research: Design and Methods,* Thousand Oaks, Sage inc.

on answers. The author has tried to downsize the cons by (1) getting input from associates on the questions and the formulation of those questions and (2) not relying on survey to be the only source of evidence but rather act as a projection.

The literature chapter was used to construct a theoretical foundation for the study. This section was written as a light discussion on the state of the art knowledge in the closest, most similar, and coherent areas that related to the objective of the study.

3.2 Subjects and form

The form of the study would be linear analytic, and the subjects of this study were related to innovation in technical management related research. In correlation with the motive for this assignment, the subjects were targeted at various national institutes in Norway, mainly: the University of Bergen, the University of Stavanger, the Norwegian University of Science and Technology (NTNU), Sintef (see *Appendix C: Sintef as a national institute in Norway*), and the University of Agder.[18]

The researchers would have their research focus in an area within technical innovation, and all subjects would have had past dealings with IPR in some

[18] Some might miss a big national institute like the University of Oslo, but, unfortunately, there were no respondents from this national institute.

way, primarily through patenting. The reason for choosing technical innovation as the focus area was because that area is very susceptible to IPR. To be assured that the researchers had been exposed to IPR, the author found suitable subjects through the patent register of the patent office in Norway (Patentstyret.no). The subjects would have to be professors, associate professors, or researchers, i.e., post doctors, associate professors II, engineers, and PHD students were not asked.

The fields of study represented in this thesis were as follows:

- *Electrical engineering*
- *Petroleum*
- *Energy*
- *Marin technology*
- *Medicine*
- *Applied Mathematics*
- *Cybernetics*
- *Design and Materials Engineering*
- *Hydraulic and Environmental Engineering*
- *Chemical Engineering*
- *Production and Quality Engineering*
- *Information technology*
- *Nano Technology*

The intent of the methodology was to provide a platform for triangulation, and data from two different aspects was collected as primary sources: an online survey and interviews. The online survey's purpose was to develop a trend curve, and then interviews would be done according to the result of the survey. Moreover, some smaller explorations was conducted that also would serve as sources of evidence for this thesis. The results and method of these has been relegated to the appendices since they only served as auxiliary sources. All subjects would remain anonymous.

3.2.1 Online survey

A simple online survey formed as a questionnaire was made with 15 questions. The first 3 questions would be dedicated to background questions in a multiple choice-setting. The next line of questions would be related to IP and IPR in a multiple-choice setting. *Appendix A: Online survey* depicts the questions of the survey. The questions were chosen because of their relationship with the objective of this study and also because of their relative simplicity. The surveys were sent out and answered between 14.03.2012 and 19.04.2012.

3.2.2 Interviews

The pool of subjects for the interviews was collected from the Norwegian University of Science and Technology and Sintef because of the author's geographical limitation. The interviews were conducted as focus interviews with discussions and were comprised of 11 questions. The author would mainly ask open-ended question and pursue a discussion if such were appropriate. *Appendix B: Interview questions* displays the questions as asked. The intent was not to lead the interviews in any direction, as the questions asked tries to reflect. The interviews were conducted in Trondheim between 16.04.12 and 21.05.12. The reason that the interview

process started before the last survey was collected was due to one stray survey that got answered later than what was expected.

3.3 Data

The data in this thesis is based on researchers' opinions and are from various national institutes in Norway. There was a 44 percent response rate for the online survey, in all 111 subjects were contacted. This was a respectable amount of subjects to reflect researcher's opinion as an exploratory study and to develop a trend curve. By choosing to only target scientists with IPR knowledge, the author tried to minimize any biases towards meaningless answers due to lack of knowledge within IPR. The subjects who responded have among them more than 640 years of research experience and have been a part of more than 350 patents.

Interviews with selected researchers were conducted to supplement the survey data and to give more depth to the report. The selection of the interviewees was based on their answers in an auxiliary question in the survey about participating in the interview process. Only researchers from Trondheim would be permitted to participate because of geographical and cash limitations that the author faced, but since Trondheim was the

geographical area with the most researchers that had responded to the survey, hopefully, no or little bias was asserted.

There was an 80 percent response rate to the interviews, 4 from Sintef and 4 from NTNU, in all 10 was asked. This amounts to 16.3 percent response rate of the total subjects who responded to the survey (49), which is a representable amount to reflect the subject pool as a whole.

3.4 Analysis and Results

The results from the online survey were scrutinized to find trends in the answers given. Every subtheme in the questionnaire was independently analyzed, but the entire questionnaire would also be analyzed as a whole. The analysis was not done by statistical method, but rather with simple observation comparison. This analysis took place before the interview questions were created to use the results from the online survey to pinpoint what questions to ask in the interview process to get a better feel for what needed to be asked.

The results from the interviews were used to offer reasons for the outcomes in the survey, and to try to depict important details where it was appropriate. The interviews would mostly rely on quotes from the

interviewees, but the author has also scrutinized the interviews to try to locate a more general reflection and feel from the interviewees.

3.5 Validity

The validity of this paper is divided in construct validity, external validity, and reliability (Yin, 2009).[19]

Construct validity is the correlation between a theoretical concept and a specific measuring device or procedure. In this study a literature chapter was created to find theoretical relationships between scientific studies and the objective of this thesis. This creates a foundation, and forms a framework for the study. Furthermore, the empirical relationships between the measurements have been highlighted through cross tabulation and connecting the results to a synergetic whole. This was done by creating specific concepts and relating them to the objectives of this study. A method of triangulations of sources was also utilized to construct the best foundation for evidence as possible.

External validity relates to how well the results can be generalized or to the degree the results are transferable to other similar contexts. This study has deducted its subjects from different geographical locations, from different

[19] Internal validity isn't needed in exploratory studies. See YIN, R. K. 2009. *Case Study Research: Design and Methods,* Thousand Oaks, Sage inc.

scientific fields of study, from different scientific environments, and from researchers with different research approaches (for example, universities do basic and applied research while Sintef favor only applied research. Probably there are also differences in research approaches across the scientific fields of study). There was also a dynamic collection of researchers' experience which ranged from little to plentiful of experience.

The author has tried to cast as wide a net as possible to make the research as universal and transferable as it could, given the time frame for the thesis and the geographical limitations the author had to succumb to.

Reliability relates to what extent the results can be duplicated with equivalent studies. The objective is to minimize errors and biases in any study. To be certain that the results of this thesis can be duplicated within this paper's framework; a thorough research methodology section was constructed, which highlighted all details, as was applicable, about the research method, the subjects, the data, and the manner the data was analyzed.

The author has also tried to maintain and display a neutral behavior when writing the questions for the online survey and when conducting the interviews to not affect the subjects of this study. The deployment of both

research methods were founded in literature (see Gillham (2000) and Merton et al. (1990)).

Chapter 4: Results and discussion regarding IPR's effect on researchers

4.1 Research

The purpose of this section was to identify if IPR is affecting or influencing researchers in their research area and research approach.

From the survey I was able to identify that most researchers have done more applied research than basic research through their career. 40 of 49 answered that they have done much or more applied research while only 7 of 49 answered that they had done much or more basic research.[20]

The result is as expected because most researchers probably have worked extensively in the private industry, and because more than a few of the researchers in the survey derived from Sintef. Additionally, when researchers apply for funds through the national research council, researchers are often require to collaborate with private companies. Emphasize on these research collaborations are often applied in nature.

[20] The author acknowledges that there can be a difference of opinion about the definition of basic research and about the definition of applied research but since this thesis is based on opinions of the researchers; it becomes natural to let them base their answers on their opinion.

Surprisingly, there was an equal amount of experience towards basic research between the Sintef researchers and University researchers, considering that Sintef's primary goal is to do applied research. The reasons for this can be many, for example, relocation of jobs or the fact that Sintef and the universities have a very tight relationship.

Additionally, it can be an indication that universities are doing much applied research. However, the author sees the limitation of this deduction since researchers with patent history may likely be doing more applied research on average than researchers without patents[21].

It is worth, however, to note all these results above because they indicate that most of the researchers, as a whole, do more applied research than basic research, and this fact relates to the bigger picture.

[21] This thesis only targeted researchers with patent history.

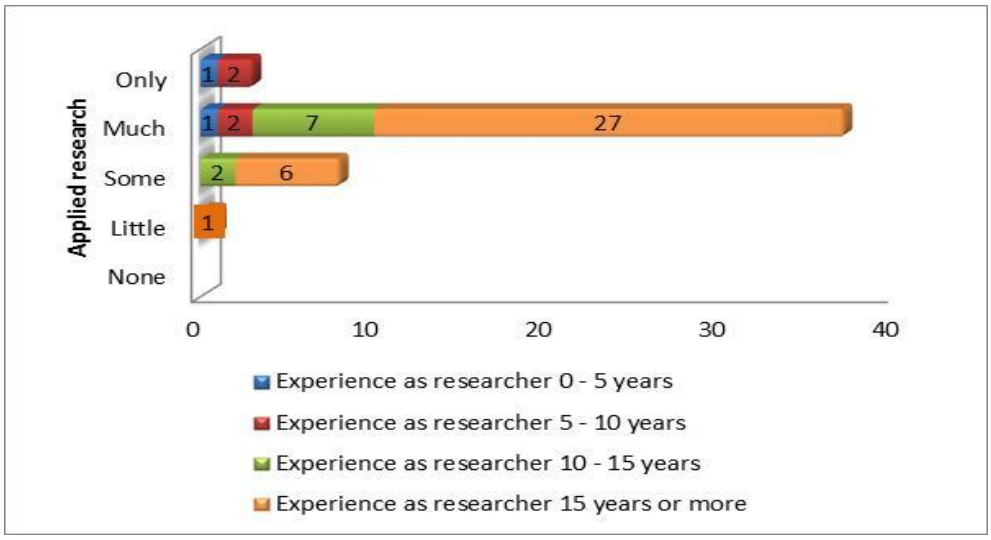


Figure 4.1-1: Cross tabulation between applied research and researchers' experience. Questions 3 and 5 in Appendix A: Online survey

The survey unveiled that those researchers with less than 15 years of experience have a greater ratio of applied research to basic research than those with more than 15 years of experience (see *Figure 4.1-1*and *Figure 4.1-2*), which points to the fact that more basic research was done 15 years ago.

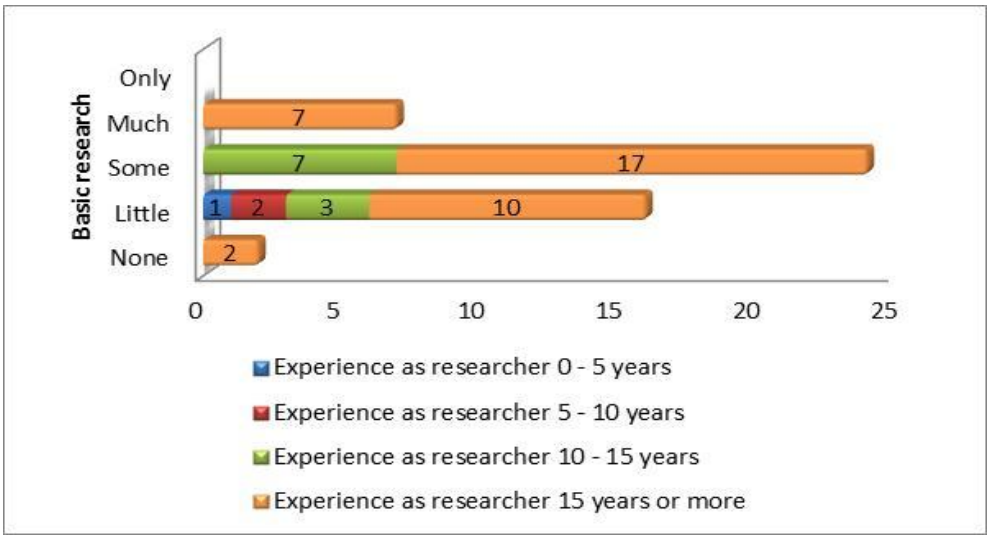


Figure 4.1-2: Cross tabulation between basic research and researchers' experience. Questions 3 and 4 in Appendix A: Online survey

This result is in agreement with believes that research is progressing from basic research to applied research. Key numbers from the Research Council of Norway (see *Appendix G: Basic and applied research funding from the Research Council of Norway*) confirmed that there has been a change. There was a difference of 46.4 million NOK towards applied research in 2006 while this difference escalated to 149.5 million NOK in 2011. Thus, more money has been allocated in total amount and as percent change. It is also worth mention that every scientific field of study represented in this study had a more concentrated approach to applied research than to basic research.

The author also asked the researchers for their views on the movement from basic research to applied research. The results are showed in *Figure 4.1-3*.

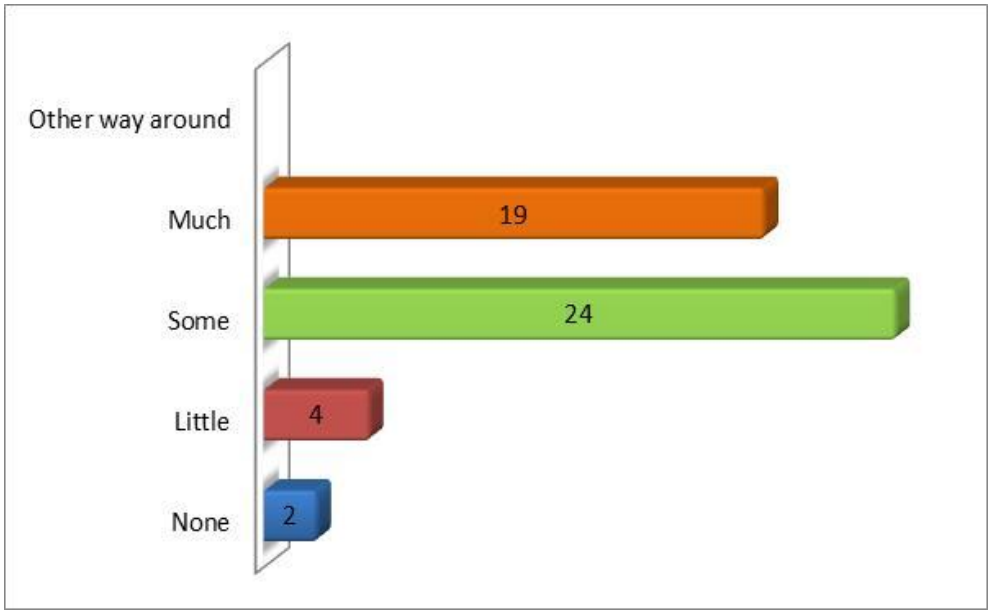


Figure 4.1-3: Researchers' opinions on a shift from basic to applied research. Question 6 in Appendix A: Online survey

One of the interviewee subjects within design and materials engineering told me that Norway is still reaping the benefits of Norwegian basic research efforts done from the 50s to the 80s, but that this well of basic research seems to be drying up.

Another stated that to him it was no more different than before, and added that he didn't know if everybody just believed there was a shift because *"everything was better in the old days"* or if there actually was a shift from basic to applied research. An explanation for this is can be personal frame of reference and background. The more experience a researcher has in his field of expertize, the less he probably would perceive research as novel or basic research.

The individual opinion on a shift is most probably derived from the researchers own field of study but they can collectively represent the whole.

It can be seen in *Figure 4.1-4* that there seems to be an overall agreement between every field of study that there is a shift. Some subjects informed me that they felt that shifts occurred with evenly spaced time periods. This latest shift can arguably be because of an explosion in IPR. It should be noted that the interviews revealed that the researchers desire a balance between basic and applied research.

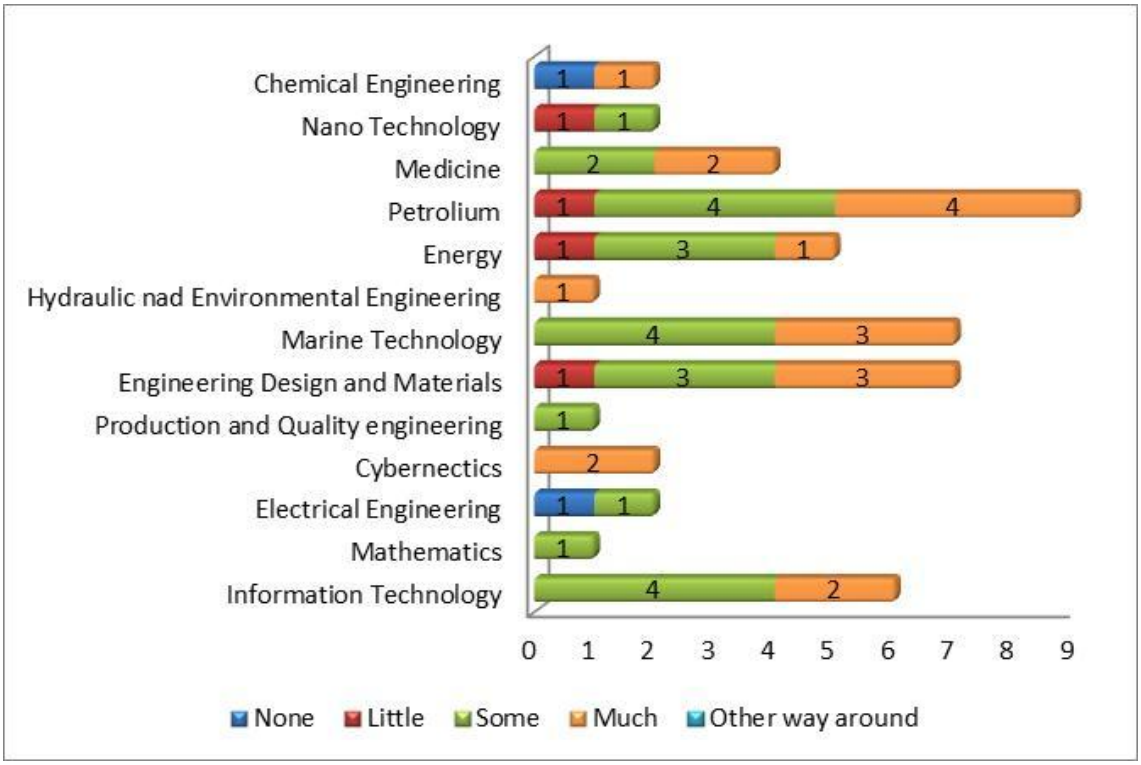


Figure 4.1-4: Cross tabulation between field of study and researchers' opinions on a shift from basic to applied research

The reasons for this apparent shift can be numerous, for instance, it can be related to more economic gain in researching in applied usage, less emphasis on long-term research, IPR, more pressure applied from institutes on researchers to get faster results in innovation, the relative public funding to the universities has decreased, or researcher's personal gain.

If universities have greater influence on how to make use of funds they receive from the state, then perhaps, to a larger degree, universities are using these funds to produce applied research for a faster and more certain source of income. If more pressure is put on universities to enter a competitive market to collect funds to cover their research expenses, then it might be easier to acquire funds if projects with immediate value are chosen.

A look into Sintef's patent application history pointed towards a greater focus on patenting in the last decade (*Appendix D: Trends in Sintef's patent applications from 1973 to 2010*) than there has ever been before. This might imply that researchers at Sintef must be more aware of IP and IPR, and that researchers are implicitly affected by IPR. One subject within marine technology at Sintef stated that they were becoming better at detecting commercial use of their research, and that:

"Basic research that doesn't have applied characteristics is hard to achieve in our department"

which means that they might produce some dual knowledge, and that increased awareness within IPR has transferred IPR to the basic research area.

The reason for Sintef pursuing patents more aggressively was because of more focus on patents and spin-off companies as a strategic tool by Sinvent, Sintef's TTO (see *Appendix D: Trends in Sintef's patent applications from 1973 to 2010)*

To get a deeper understanding of how all results above were related to IPR, the author asked if IPR is influencing their choice of research area and research approach (question 7 in *Appendix A: Online survey*). The result was a split around about 50 percent stating that IPR influences a lot with the rest stating that it isn't a concern. A deduction of this is that some of the researchers desire to do applied research, which is obviously within logically reason, i.e., they are not driven to applied research, it is their own choice. One should not overlook the premise that stronger IPR has made applied research more lucrative.

The interviews gave some answers to why IPR is influencing research areas and research approach. One reason was regarding patent protections

and how it hindered some approaches (regarding open science, etc.), and that IPR also made some areas obsolete because a certain technology already was patented. Another reason was that it is easier to patent in some technological areas and that, if that area was chosen, the focus would be on the industrial area with the greatest market potential.

50 percent of the participants answered that their freedom of choice and action has been reduced because of IPR in the later years (question 8 in *Appendix A: Online survey*). A discovered reason for this was that companies and the Research Council of Norway have established more boundaries than before. Interestingly two answered in the survey that their freedom of choice have increased but none of them participated in the interviews.

The author believes that IPR (in accordance with globalization and more competition) is affecting researchers in their research area and research approach. There was a clear notion that a shift from basic to applied research is in progress in Norway and researchers are recognizing it. Some researchers are picking research areas based on patentability and commercial value (or not pursuing other directions because of lack of commercial value). One interviewee within the universities stated that researchers' integrity was at stake. He felt that no longer was research done for the greater good, but rather for commercial value. There was a notion

among the interviewees that there should be a balance between basic and applied research, although, at this moment, there was an unbalance towards applied. Additionally, a noticeable change in the distribution of grants was seen in the Research Council of Norway, a change towards applied research.

4.2 Access to technology

The purpose of this section was to identify if researchers actively employ patent registers and databases in research projects, and if there has been perceptual change in accessible to state of the art knowledge, information, and technology.

The latter statement implies two things. First, the accessibility of state of the art knowledge, information and technology has as much to do to with searching as restriction. Because of globalization, the internet, networking, and so on, it has become easier and quicker to search and gain access to more data and information than before. The computer combined with the internet has especially increased the flow of information throughout the scientific community. One perspective of this question will consequently be regarding the ability to find state of the art information and technology in a swift and accurate way.

Second, the accessibility can also be directed towards the restriction, or the lack of, in state of the art information and technology. The ability to protect intellectual property, as in patents and copyrights, can restrict or delay researchers in gaining access to state of the art technology, while trade secrets can restrict access to state of the art knowledge, information, and technology.

The intent of this section was, hopefully, to make the respondents answer when considering their ability to locate, access, and apprehend state of the art knowledge, information, and technology which meant considering both perspectives and reach a decision on whether access has decline or increased, in their opinion, in the later years as a whole. *Figure 4.2-1* depicts the results on the question to the accessibility of state of the art knowledge.

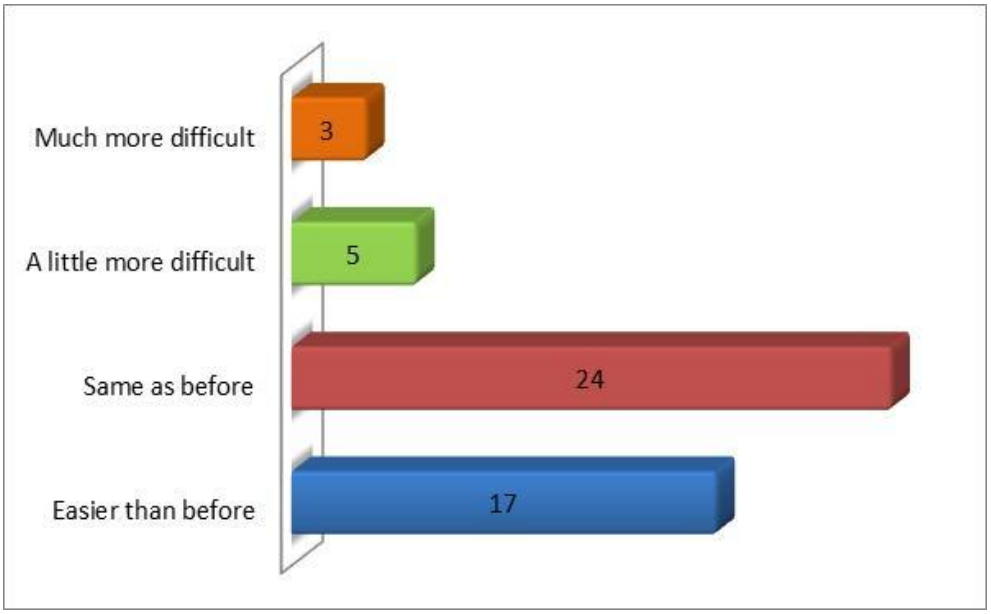


Figure 4.2-1: Researchers' answers to a change in access to state of the art knowledge. Question 10 in Appendix A: Online survey

From the interviews it was discovered that the main reasons for easier access to state of the art knowledge, as well as state of the art information and technology, are because of the technological advancement within computer and search engines. *No one in the interviews displayed concerns about patents hindering access to state of the art technology which further research could be built upon*.

Search engines has made the scientific community expand faster than IPR ability to hinder innovation (IPR's intent is not to hinder innovation, but that may be a fallout). The result is that the area of innovation is so immense that a few patents or trade secrets won't hinder innovation.

The conception that IPR and trade secrets might hinder access to state of the art might be true, but the results point to the conclusion that innovations, such as the personal computer and the internet, have made it easier to share and thus made it possible for faster and easier innovation.

Even if IPR and trade secrets hinders innovation, researchers have never had more opportunities to originate their new research projects in earlier technologies. This deduction deems it difficult to make definite conclusions on whether IPR hinders innovation or not because the researchers' answers would be polluted by the notion that more state of the art knowledge, information or technology is more reachable than before.[22]

Not only have search engines made it easier to gain access to prudent knowledge, information, and technology, but maybe they have made it easier to avoid researching in an area that is heavily patented or to avoid already patented technology. However, patents are crafted by lawyers and patent engineers who uses an own patent language, hence an unique type of competency is required to write and read patents, a competency researchers are not expected to excel in. Still, with the support of TTOs, researchers might use patent databases and registries with some degree of success.

[22] Most researchers are not experts on IP-system and may be filled with misconceptions about IP-system, but since this study is mostly based on the opinions of the researchers, this possible fact will be disregarded.

Figure 4.2-2 depicts how the researchers answered in the survey regarding the use of patent registries and databases in their research process.

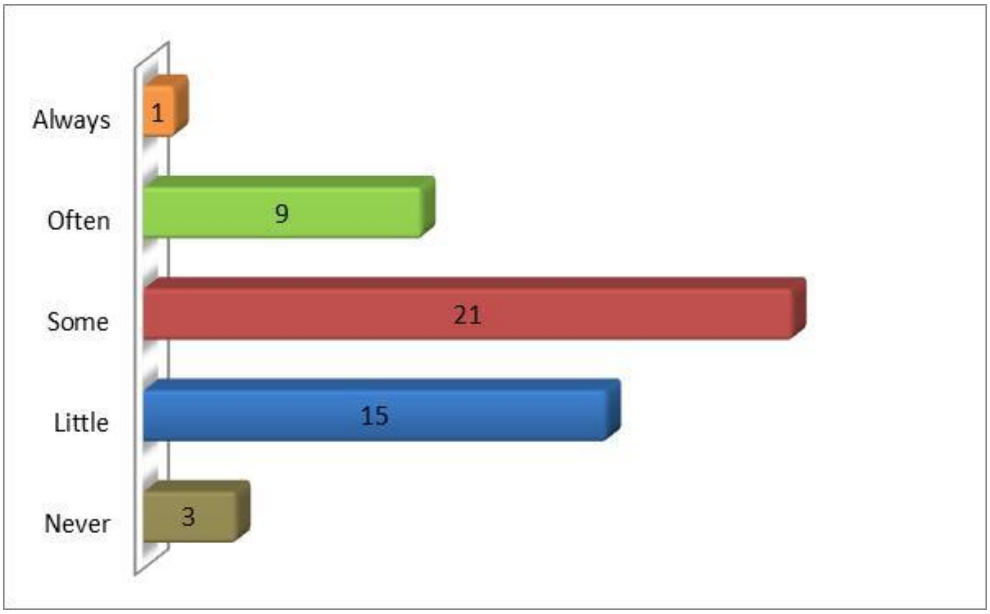


Figure 4.2-2: Researchers' answers to the amount of usage of patent registries and databases. Question 9 in Appendix A: Online survey

Patent registers and databases are obviously a part of modern scientific research. This implies that there are two views on whether IPR affects researchers in this area. If researchers are using time and effort to search in patent registers then obviously they are affected in some way by IPR, but at the same time they are using these registers as a preventive mechanism to avoid being affected by IPR in the future. One subject stated that

"It has happened that that a discovered patent has made it less interesting to go in a certain direction"

The same subject commented that patents were an obliviously small issue when researching.

An investigation in Sintef's and NTNU's patent records to discover a general foundation of how long patents are held on average (*Appendix E: The length of time which patents are held at Sintef and NTNU*) revealed that most patents, in this context, are probably held for ten years or more. This would imply that patents could hinder innovation, but the interview process revealed that none had ever been hindered by a patent in such a way that it hindered innovation. There was, however, a stronger concern about trade secrets*:*

"The collaboration environment has become smaller (because of trade secrets). We aren't getting enough details from the industry".

Because national institutes are becoming more commercialized, they might be considered as a rival to private companies in some fields and areas. This might affect the relationship between the private industry and national institutes in the future.

The author believes that IPR does not affect nor hinder in a great amount researchers in the area of accessibility of knowledge, information, and technology. Most of the researchers in the interviews stated that patents didn't at all hinder innovation or access to state of the art information and

technology. The searching capabilities and data accessibility due to the personal computer and the internet has evolved faster than IPR, and as a result, more knowledge, information, and technology are reachable than before. Remarks from the researchers in this study pointed to trade secrets being elevated as a treat to open science.

4.3 Future research and communication

One aspect of IPR is that it may restrict the usability of the knowledge, the information, and the results gained in one project in another project if a researcher is not listed as an owner of such information or results. For example, if a researcher is hired by a third party and negotiate an agreement about the restriction of the distribution of the information and results, the researcher might not be legally able or ethically able to use any knowledge, information, or results gained in research projects that are controlled by the third party in any further research when it is outside the scope of the third party.

Though IPR isn’t a young concept, it is truly in the later years that IPR has exploded as a consequence of globalization. The author asked if the subjects found it more difficult now than in their earlier researching years

to use results from their earlier research projects in future ones. The answers are depicted in *Figure 4.3-1*.

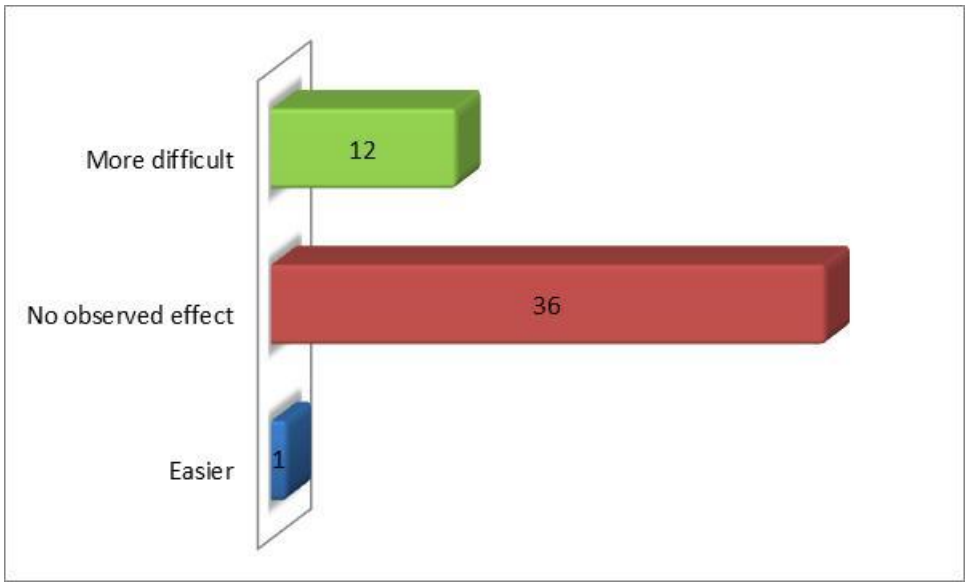


Figure 4.3-1: Researchers' answers to the opportunity of using research project results in future research projects. Question 11 in Appendix A: Online survey

The interviews confirmed that transferring knowledge, information, and results from previous research projects has never been and is of little concern. Obviously, using the original product would be of difficulty, but using the results which the product was based on was not. A subject stated that:

"If it is a definite technology than maybe, but there are so much similar technologies out there (to use as a foundation that it never would be a problem)".

One interviewee commented that it might be hard to use the results within a period of time after a project because the results were sometimes tied up for a couple of years due to non-disclosure agreements.

When question 6, *Is IPR hindering you in acquiring help and information from fellow researchers and professors in the science community network or associates without infringing IPR on a given research project?* (*Appendix B: Interview questions*), was asked in the interview process, most answered a plain *"no".* The author sees no result of the anticommons effect on national researchers.

None of the interviewed subjects stated any problems of having an open dialog with co-workers and fellow researchers outside of the research project group. Obviously, the most sensitive data would be left out of those discussions, as also the survey reflects with 46 of 49 answered that they had become more aware of what information to disclose due to IPR (question 12 in *Appendix A: Online survey*). An interviewee stated that he believed private companies employed universities and Sintef because of their vast network and their opportunity to gain access to state of the art knowledge, information, and technology through their open networks (this insinuates the use of innovation systems).

However, a rising concern of the researchers were integrity, i.e., how *much* information and knowledge researchers can use on later projects without overstepping their ethical boundaries, especially if the assignment was in direct rivalry with a previous assignment done for another company within the same industrial area. It was difficult to obtain data about whether researchers aren't hindered because of IPR agreements (contracts), lack of ethics, or lack of awareness from the researchers without violating the interviewees' personal space.

The author believes that IPR is not affecting nor hindering researchers in future research. There seemed to be no problem in using knowledge, information, or the results gained in future research projects though using the specific product would be off limits. Even though few say it is more difficult, it's still very much possible. Additionally, there seems to be few limitations on obtaining outside help from fellow researchers and associates while in a research project environment.

4.4 Disclosure

The purpose of this section was to try to identify if researchers are for open science or commercialization. The answer choices would give the

respondents opportunity to reflect if they desire to use IPR as part of their research process or if they elect to choose other means of disclosure.

Figure 4.4-1 shows the results for what was answered to be the respondents' favorite type of disclosure. There is a definite weight on conferences and publication, which is pointing towards that the respondents are for an open science community.

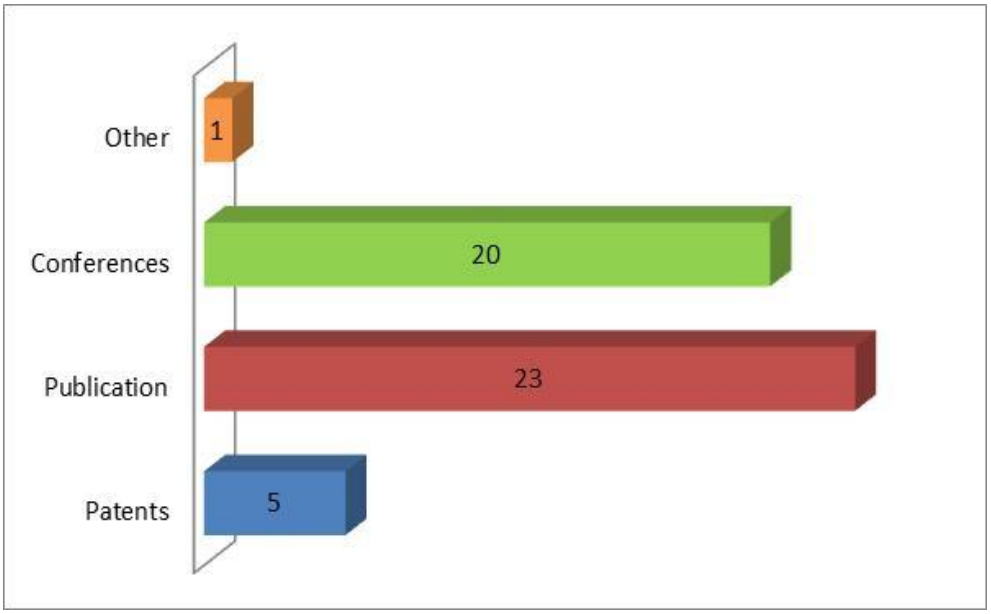


Figure 4.4-1: Researchers' answers on their favorite way of disclosure. Question 13 in Appendix A: Online survey

Patents don't necessarily divulge all information about an innovation, most likely only the amount needed to get a patent granted. However, patents can be a vital part of a researcher's work. A subject within medicine stated that:

"(We) have to patent to get it commercialized. If we publish then we would destroy the technology because it would hinder patients getting what they need"

The reason for this is that if an idea is published before patenting in the field of medicine, then there are no investors that want to touch the idea because of the cost of clinical trials. No company wants to take that cost without ensuring that they have a patent (monopoly) that they can profit from later in time.

Patents can also be a contributor to open science and publishing. On this matter a subject within design and materials engineering stated that:

"If the third party company (that I was engaged by) hadn't taken out a patent, then I wouldn't be able to publish my work (because it would have been a trade secret instead)"

In this field of study, which was within industrial processes, there is a shift from patents to trade secrets, because:

"It was impossible to make sure that others didn't use the same technology".

Another subject also pointed out this fact within another field of study and commented that there are a lot of trade secrets among companies, and that

this never used to be the case. He too was seeing a shift from patents to trade secrets.

Furthermore, 71 percent of the respondents replied that there is some conflict with their employer on the issue of disclosure (question 14 in *Appendix A: Online survey*). *Figure 4.4-2* displays the cross tabulated results between favorite publication and conflict with employer.

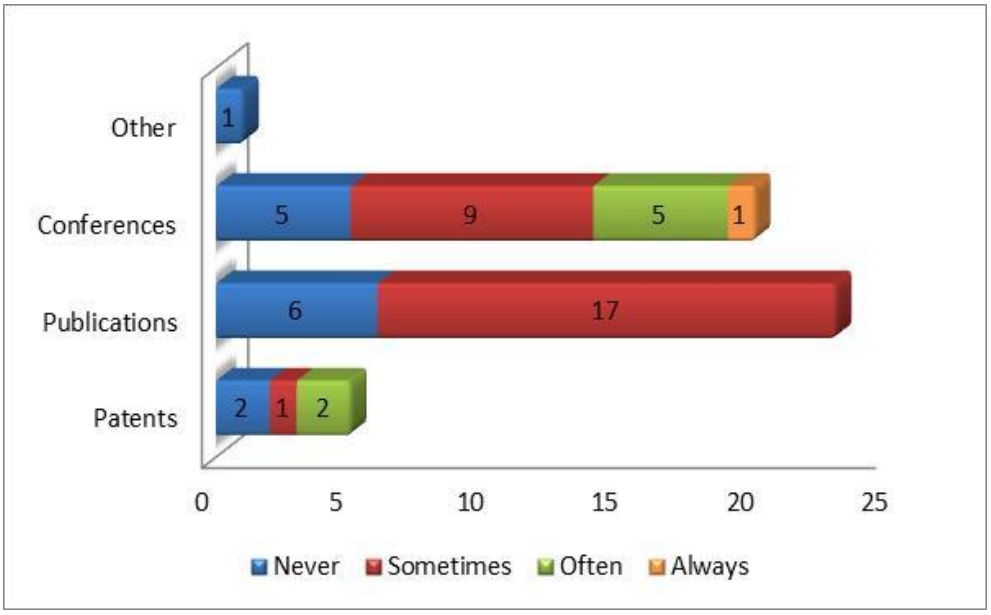


Figure 4.4-2: Cross tabulation between researchers' favorite type of disclosure and researchers' rate of conflict with employer regarding disclosure. Question 13 and 14 in Appendix A: Online survey

Throughout the interview process other sources of conflicts related to IPR was revealed. These were related to the time and effort (1) that goes to negotiate the non disclosement agreements, (2) that goes to bureaucracy, and (3) that goes to assist in the patent application process. Thus, even with the use of TTO's, the time spent on administration is significant.

Additionally, the author asked if IPR had ever halted or ended a research project, the results are displayed in *Figure 4.4-3*. Possible reasons for halts are time lag, disagreement on what is open information and what is confidential, and other administration related incidents. The most likely reason for a termination is disagreement about confidentiality and disagreement about ownership. The results imply that IPR isn't affecting researchers much regarding project termination and halts. Though 1 of 4 has been affected more than once, there is a strong possibility that most projects did not succumb to termination and that these affected times are probably very few times relative to all their research projects.

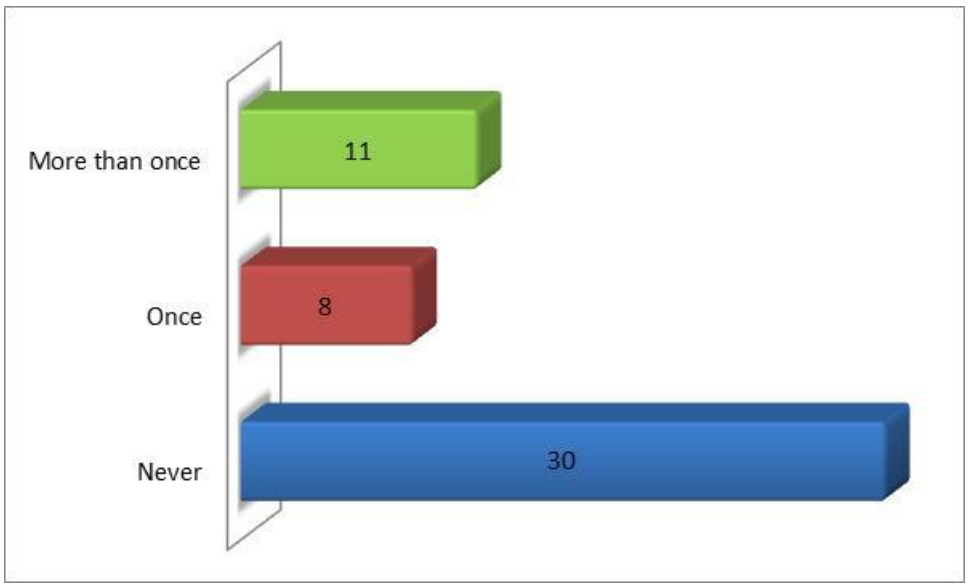


Figure 4.4-3: Researchers' answers to how often a research project have halted or ended due to IPR. Question 15 in Appendix A: Online survey[23]

[23] The author gives himself self-criticism for not dividing this question into two parts, one for project halt and one for project termination.

The author believes that IPR is affecting researchers in the area of disclosure. Most researchers desire to publish instead of patenting even if both can be achieved, though publicizing information in a patent will have to be done after a time lag. Administration was also greatly affecting researchers due to time consumption.

However, IPR is not hindering researchers in a great amount. Actually, in some areas, patents are a strongly welcomed (although trade secrets obviously are not). It should be mention that the interview process revealed that the researchers didn't think that they were pressured by their employer to take out patents. But the law in Norway state that if there is an innovation worth mentioning, then it is the responsibility of the researchers to disclose such information.

There were some that have had a research project halted or ended, but they were unrepresented in the interview process and so no comments on that subject was attained.

4.5 Researchers' comments on IPR

In the interview process two simple leading statements (similar to an open ended question) were stated by the author to the interviewees where the respondents could expand more in detail towards IPR.

- Statement one: Comment on the way IPR is hindering you
- Statement two: Comment on the way IPR is supporting you

As it will be seen in *Table 4.5-1* and *Table 4.5-2*, the strongest arguments against IPR by the researchers are the effort and time spent on administration, which could possibly be spent on research instead. Some of the comments point out that an IPR-incentive towards national researchers isn't present. A reason for the lack of incentive might be that patents don't give publication points for the university employees, which they are ranked on.

The strongest argument for IPR was industrialization and network development, but how IPR supports the researchers was strongly correlated with their fields of study.

Table 4.5-1: Researchers' comments on how IPR was hindering them

"A negative thing is the time lag. I have some papers in my drawer that I want to publish but I have to wait eighteen months because then it goes public anyway".
"(I want to point out) bureaucracy and clauses about confidentiality. Months can go by before anything is done and we're been held up as a result. We can't start a project before the confidentiality agreement is secured"
"Others have had the rights (to a technology) so there haven't been any reason to research in that direction (because it was already patented)"
"The conflict is related to what is open information and what is to be kept secret. It has occurred that we have been hindered in this way."
"Not as a researcher at NTNU because I work with processes, but in the industry there were cases we had troubles. Though time lag can be an issue.
"(I have) never been hindered by a patent. I have been hindered in one patent application but that is all. I'm not hindered by IPR"
"Never been affected (in ill-fated manner)"
"The cooperation environment has become smaller. We aren't revealed much details (from our provisional employer) on the research we are doing"

Table 4.5-2: Researchers' comments on how IPR was supporting them

"(it's beneficial) for us who likes to see a product in the shelf. It is also easier to gain access to networks that has bigger agents who can offer complementary technology that leads to an higher level of competence"
"I don't feel it supports me in a great way. I have been a part of some patents and gotten some money (but is to more hinder than support)"
"We have taken patents and that has worked out well. (I) think that everything should be patented"
"Never supported me"
"It is a vital part of industrializing research results"
"(I have) no incentives to apply for a patent. We are rated (within the university) through publications"
"To secure that we have the rights (to an idea or product) such that the private industry wants to join us in further development"
"There is no incentive to apply for a patent"

Chapter 5: Conclusion and Future research

5.1 Conclusion

The study of the interaction between IPR and researchers is an important area of research that has received modest empirical analysis. Many of the researchers who contributed to this study remarked that research in this area was past due. A study based on Norwegian researchers is a worthy research area due to possible soon to be reforms within IPR-laws in Norway.

Through the empirical study using a survey and interviews to acquire the opinions of researchers in Norway regarding IPR, the author has discussed the impact that IPR has on researchers' choice of research area, accessibility to knowledge; information; and technology, future research and communication, and disclosure. The author has also accentuated some of the opinions that researchers have on how IPR is hindering or supporting their cause.

It seems evident that IPR is affecting researchers, whether it be consciously or unconsciously, but not in a manner which yield great effect on

innovation. The evidence shows that there is a shift from basic research to applied research, a change that undoubtedly also will provoke change in problem statements, research area, and research approach. This shift might pose a dilemma for university researchers regarding ethics, i.e., what research is best for society and what is best for commercial value.

There seems to be few restrictions on the accessibility to state of the art knowledge, information, and technology. Some authors, which is mention in the literature chapter, have implied that patents, especially, is slowing the innovation process. This might be true in R&D in the private industry, but this seems to lack foundation in R&D in national institutes. No researchers stated that patents were obstructing innovation in their field of studies. The emergence of data and internet has shrunk the limitations that patents might pose. However, trade secrets have been discovered to be a threat to innovation and to the open science community due to its secrecy and its inability to be published.

Researchers are not hindered by IPR in future research projects when they desire to use the knowledge, information, or results gained in previous research projects. Obviously, the definite product researched is off limits. It’s unclear if researchers aren’t hindered because of IPR agreements (contracts), lack of ethics, or the lack of awareness of researchers. In the opinion of the author it is probably a combination between unawareness

and the national institute's ability to script a contract that is beneficial to their cause.

Researchers are strongly affected in the area of disclosure, but not in a way that is hindering innovation as much as delaying. Although more of the researchers' time is allocated to administration because of IPR, which can imply that less time is spent on research. In some fields of study IPR is essential to get the information and technology out to society. IPR doesn't seem to halt or end research project to a great extent, but the effects on this are at this point too uncertain to conclude.

IPR is a natural element of modern society and it doesn't seem to hinder innovation among most of the national and public researchers, though, some fields of study are probably slightly more affected than others.

5.2 Future research and limitations of study

This thesis is primarily a small qualitative empirical study, augmented by a set of semiquantitative evidence. Thus, the study doesn't have the rigorousness as a quantitative study involving definite numbers and data nor as a fully qualitative study involving a greater time span, extensive field work, and more interviews. Another limitation is that the study is solemnly confided to Norway and Norwegian researchers. A qualitative

empirical study on a grander scale is definitely a potential area for further research, as is the potential for doing an international based study.

As with all survey based research there is a limitation on how to execute the questions and its limits in the choices of answers. The author has acknowledged that a scarce of the questions in the survey could have been better formulated. The author also wanted to do more interviews, but, discontentedly, there were no more volunteers.

Ehrat (1997) mentioned that ninety percent of all patents are not protected due to expiration, rejection, retraction or non-extension and are free to use for whomever who wants to use them. In this thesis it was concluded that this is enough to progress with innovation. However, to what degree ninety percent is enough should pose as a potential interesting area for further research done in a bigger scenario. Additionally, this study identified that trade secrets is a tool that is on the rise, which didn’t seem to be compatible with public researchers and open science. More research on trade secrets and its effect on researchers and open science may be needed.

Appendices

Appendix A: Online survey questions

Background

1. At which institute do you work?
2. In which field do you do research?
3. How long have you been a researcher?

Research area

4. If you look at the total extent of your career as a researcher, how much of the research can be called BASIC research?
5. If you look at the total extent of your career as a researcher, how much of the research can be called APPLIED research?
6. Some researchers have stated that there has been a change in basic research to applied research, to what extent do you think this is true?
7. Do issues relating to IPR influence your choice of problem/research areas and research approaches?
8. In your opinion as a researcher, has your freedom of choice and action, increased or decreased during the later years as a result of IPR?

Access to state of the art

9. To what extent do you use patent databases/registries as an integrated part of doing a research project?
10. In the later years, in your opinion, have you noticed a perceptible change in access to state of the art knowledge?

Future research

11. Some researchers have stated that IPR has made it more difficult to use results from previous research as part of later projects. To what degree do you agree?
12. Do you believe that you, consciously or unconsciously, are more careful about with whom you share knowledge, due to possible IPR infringements?

Disclosure

13. What is your favorite type of disclosure?
14. Is there any conflict between personally preferred choice of disclosure and the type of disclosure allowed by companies or your employer?
15. Has implications of IPR halted or ended a research project?

Appendix B: Interview questions

1. Most researchers answered in the survey that they have experienced a shift from basic to applied research. Can you explain, in your opinion, why you/researchers have (haven't) experienced a shift from basic to applied?
2. Most of the researchers in the survey felt that their freedom of choice has decreased due to IPR. Can you elaborate on why you/researchers feel that their freedom of choice has (hasn't) decreased due to IPR?
3. How does IPR influence your research approach and area?
4. Many researchers answered that the availability of state of the art has increased. Can you comment on this?
5. Do you find it difficult to use knowledge, information or results from past research projects in future research projects? Comment on why, in your experience, you feel that it is (not) difficult or why it is (not) an obstacle.
6. Is IPR hindering you in acquiring help and information from associates and fellow researchers and professors in the science community network without infringing IPR on a given research project?
7. Most respondents stated that they have had some kind of conflict with their employer on disclosure issues. In your experience, what do you think is the base for these conflicts?
8. Have you had other conflicts with your employer because of IPR that was not related to disclosure?

9. Comment on ways IPR is hindering you.
10. Comment on ways IPR is supporting you.
11. Additional comments on the subject?

Appendix C: Sintef as a national institute in Norway

It is important that the reader is aware of the differences between Sintef (Sintef, 2012), which is actually an independent national research facility, and Norwegian universities. Sintef was established in 1950 by a Norwegian university, namely the Norwegian University of Science and Technology (NTNU). However, Sintef was in 1980 further developed in to an independent company with their own administration and management. NTNU and Sintef extended their cooperation in a partnership, and many scientists and professors were employed with so called double roles for both NTNU and Sintef, as they still do today.

In 1993 the University in Oslo and Sintef agreed to a partnership as well, and Sintef was recognized as a national institute. Sintef is a non-profit organization and all profits go to further development of technology. A critical difference between the universities and Sintef is that Sintef mainly focuses their research on applied research, which is acquired by private companies. However, since many of their staff is employed in universities

as well, they are probably subjected to both applied research and basic research. Several sources have stated that Sintef do basic research as well, though to a smaller extent.

Appendix D: Trends in Sintef's patent applications from 1973 to 2010

Sintef is a private and non-commercial research facility that focuses on applied research (see *Appendix C: Sintef as a national institute in Norway*). Unlike universities, which did not own their researcher's ideas until 2003, Sintef can be a research subject for investigating tendencies within patent development. If we look at the patent application from 1973 until 2010[24], we can create a picture of how the development of IPR has proceeded within this organization, and thus collect more valuable evidence on if IPR has affected researchers in the later years.

The hypothesis would thus be that an increase in average patent application per year on a year basis from 1973 until 2010 would be an indication of researchers being affected consciously or unconsciously. worthless

[24] Investigations in patents after 2010 are valueless because patents aren't made public until latest 18 months after filing. Thus many cases in 2011 and 2012 might not be accounted for.

Research methodology

The research method was semiquantitative (see chapter 3.1 for more information). The author searched the Norwegian patent directory online (Patentstyret, 2012) for the number of patents application from Sintef and Sinvent[25]. Either of those two had to be registered as applicant or owner. Every patent application has been counted regardless of application success or not. The result has been adjusted for duplication, i.e., if both Sintef and Sinvent had their names as owner or applicant, only one patent was counted.

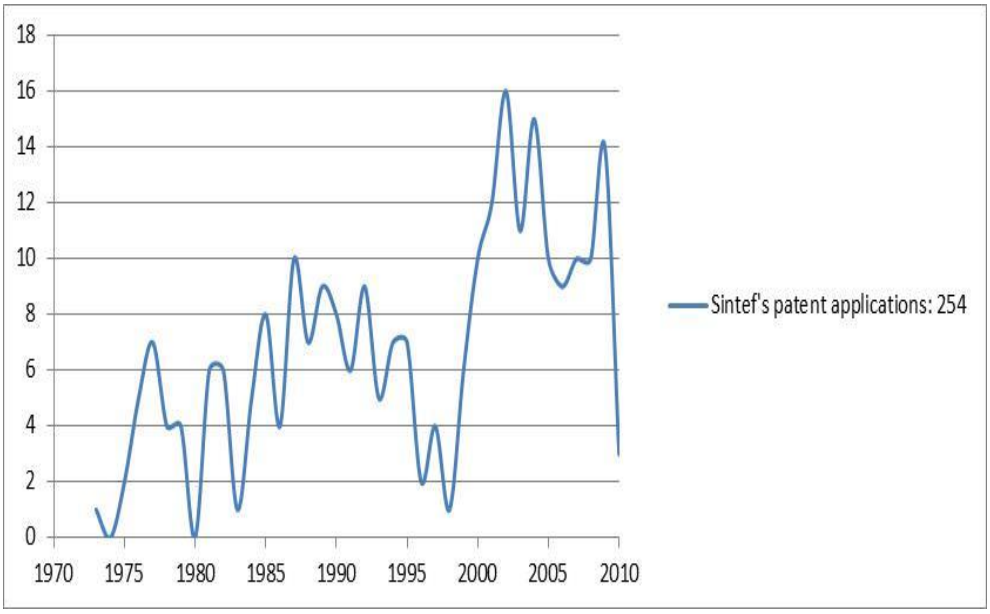
Using patents to measure innovation have been used by Trajtenberg et al. (1997), Hall et al. (2001), and Huang (2006) because of its fruitful source of data. As previous researchers have noticed, there are some limitations to the use of patents (See Huang (2006), chapter 5.3). However, the research done with patents in this study is most likely to small to be taken effect of these limitations.

Results

The results are depicted in the *figure* below. The reason for the boom in patents in 2002 is because of increased focus on applying for patents and producing spin-off companies as a strategic tool by Sinvent (Sintef's TTO).

[25] Sinvent is Sintef's technology transfer office. This is an office that deals with IP and IPR related cases at Sintef.

In 2002, Sinvent became an active organization (Sinvent was established in the early 90s but only as a passive organization) that regarded intellectual property as an important tool (Herje, 2012).



A probable reason for the decline in 2010 can be that companies are devoted less money to research because of the financial crisis or it can be a natural anomaly. We can see that the average application per year from the year 2000 is almost constant higher than before the year 2000. If there is an increased focus on patent application, then Sintef might require their researchers to be more aware of IP and IPR. Implicitly this means that the IPR policy of Sintef is affecting their researchers in some ways.

Appendix E: The length of time which patents are held at Sintef and NTNU

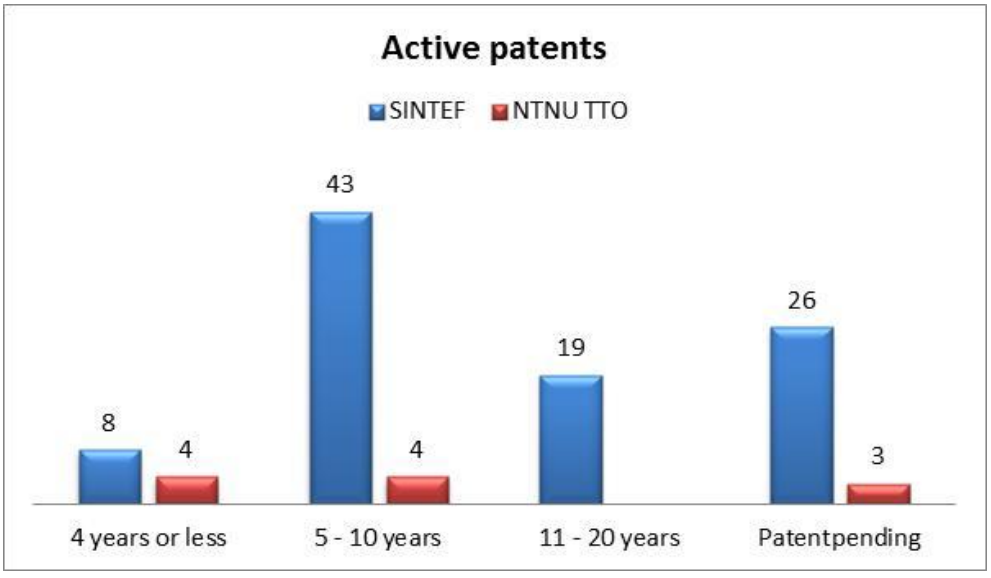
Ehrat (1997) stated that ninety percent of patents are available to use by the public as they no longer are protected. However, he didn't account for the length of time of which patents are held, which would be a value piece of information regarding if patenting is affecting scientists. If more often than not patents are a held over a longer timeframe, then obviously this might hamper scientific research (if we assume that the patent isn't released to the public without charge).

Research methodology

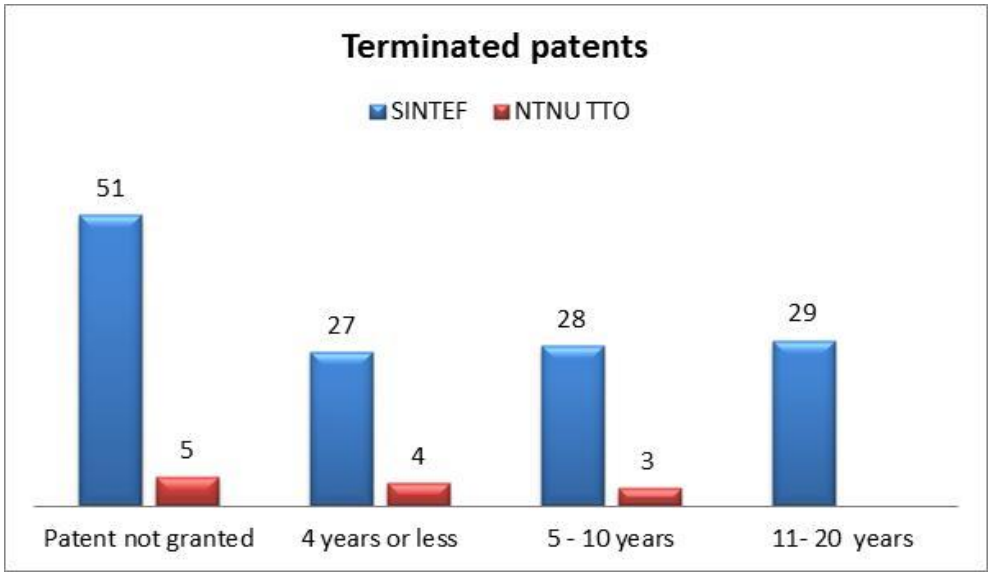
The research was semiquantitative (see chapter 3.1 for more information). The author searched the Norwegian patent directory online (Patentstyret, 2012) for the patent applications by Sintef (and Sinvent) and the Norwegian University of Science and Technology (NTNU). The results would be divided in two categories: Terminated patents and Active patents. Note that when a patent is granted the patent seeker must make a onetime payment for the first three years, and hence there is no difference between patent holdings from year one to year three.

Using patents to measure innovation have been used by Trajtenberg et al. (1997), Hall et al. (2001), and Huang (2006) because of its fruitful source of data. As previous researchers have noticed, there are some limitations to the use of patents (See Huang (2006), chapter 5.3). However, the research done with patents in this study is most likely to small to be taken effect of these limitations.

Results



The results are showed in the two *figures*. Sintef had a total of 135 terminated patents (an additional 24 was found, but due to unknown patent holding the author has chosen to disregard these to avoid bias) and a total of 96 active patents.



Sintef has roughly a 78 percent approval rate on their patent applications (patent pending included); or stated in another way, only 1 out 5 patent is granted. 24 percent of all patents have been terminated within ten years (not including patents not granted). However, the majority of the active patents are between five and ten years so there is a possibility that many of these will tip ten years.

NTNU had a total of 12 terminated patens and a total of 11 active patents. NTNU has roughly a 78 percent approval rate on their patent applications (patent pending included). 30 percent of all patents have been terminated within ten years (not including patent not granted).

The results show that the majority of patents are held for a long period of time. Nevertheless, the field of study (i.e., within medicine, chemistry, energy, etc.) of which the patents lay in is of importance. Some industrial

areas have a fast turnover and innovation rate, and to have patents that last for more than the turnover rate might be useless. One should not look at years as a definite measurement, because two years in one field of study can be equivalent to six years in another field of study regarding the delaying of innovation. However, if patents are made open in a short period of time, other researchers can use these patents (or technology) as a foundation or bricks in their research. The conclusion must be that most patents are on average held for a longer period of time, most probably more than ten years.

Appendix G: Basic and applied research funding from the Research Council of Norway

A big contributor to research in Norway is the Research Council of Norway (RCN). The RCN is funding national institutes, private companies, and independent researchers with different types of programs that serve to cover the planned needs of Norway. The funding can be allocated to basic research as well as applied research. The author found no numbers on how much money Norwegian private companies are focusing on basic research, thus the RCN becomes the only viable “subject” to measure in terms of if there is a shift from basic research to applied research or the opposite.

The different programs that RCN offers

To decipher the results it is important to know the difference between the various programs that the RCN is funding. The RCN offers five programs (The Research Council of Norway, 2012a) that can be categorized under basic research, applied research, and "not relevant for this thesis":

- Basic research: basic research programs and independent projects.
- Applied research: user directed programs
- Not relevant: policy-oriented programs and large programs

Basic research programs are defined to secure knowledge and competence in the form of basic research within certain areas. Independent projects are designed to preserve free researcher initiated basic research that isn't connected to a research program.

User directed programs are designed for companies that mostly want to do applied research to achieve its industry-oriented R&D objectives.

Policy-oriented programs are primarily sociological in nature and thus irrelevant for this report. Large-scale programs are tools to execute national research priorities. These programs will have a combination of both basic research and applied research, and thus become hard to interpret.

Research methodology

The author utilized the RCN key numbers (The Research Council of Norway, 2012b) to pinpoint where money has been allocated from 2006 to 2011.

Results

The Research Council of Norway's grants distributed on research programs in millions NOK.								
	2006	2007	2008	2009	2010	2011	Share of the total in 2011	Change from 2006-2011
User directed programs	698.0	815.5	986.5	1 179.1	982.9	908.2	14 %	30 %
Basic research programs	196.2	268.5	247.0	228.7	229.9	191.6	3 %	-2 %
Independent projects	455.4	475.3	487.6	447.6	541.7	567.1	9 %	25 %

The results are depicted in the *table*[26] above. Both total the amount allocated in 2011 and total change in allocation from 2006 to 2011 are supporting the belief that there is a shift from basic research to applied research. There was a difference of 46.4 million NOK towards applied research in 2006 while this difference escalated to 149.5 million NOK in 2011. Thus, more money has been allocated in total amount and as percent change.

[26] The table was modified by the author. To see the table's original form, see the source for the table in the research methodology in the underlying appendix.

References

AGRAWAL, A. & HENDERSON, R. 2002. Putting patents into contect: exploring knowledge transfer from MIT. *Management science,* 48**,** 44-60.

ARGYRES, N. & LIEBESKIND, J. 1998. Privatizing the Intellectual commons: Universitites and the Commercialization of Biotechnology Research. *Journal of Economic Behavior and Organization*.

ARORA, A., CECCAGNOLI, M. & COHEN, W. M. 2003. R&D and the patent premium. *NBER Working Paper, January, 9431*.

ARROW, K. 1962. Economic Welfare and the Allocation of Resources for Invention. *In:* NELSON, R. R. (ed.) *In The Rate and Direction of Invetive Activity.* Princeton, NJ: Princetion University Press.

ATHREYE, S. & CANTELL, J. 2005. Creating competition?: Globalisation and the emergence of new technology producers. *Research Policy,* 36**,** 209-226.

BADER, M. A. 2006. *Intellectual Property Management in R&D Collaborations: the case of the service Industry Sector,* Heidelberg, Physica-verlag.

BAECKER, P. 2007. *Real Options and intellectual Property: Capital Budgeting Under Imperfect Patent Protection,* Heidelberg, Springer-Verlag.

BOLDRIN, M. & LEVINE, D. 2002. The case Against Intellectual Property. *CEPR Discussion Paper No. 3273.*

CHANG, H.-J. 2001. Intellectual Property Rights and Economic Development - Historical Lessons and Emerging Issues. *Journal of Human Development,* 2.

COCKBURN, I. & HENDERSON, R. 1998. Absorptive Capacity, Coauthoring Behavior, and the Organization of Research in Drug Discovery. *Journal of Industrial Economics* 46**,** 157-182.

CZARNITZKI, D., HUSSINGER, K. & SCHNEIDER, C. 2011. R&D collaboration with uncertain intellectual property rights. *ZEW Discussion papers, NO.11-010*.

DAVID, P. 2001. Will building Good Fences really make Good Neighbors in Science. *Stanford Working Paper #01-005*.

DAVID, P. 2003. Can "Open Science" be Protected from the evolving Regime of IPR Protections? *Stanford Working Paper #03-011*.

DOMSTOL.NO. 2009. *Spørsmål om en forskningsstiftelse begikk middelbart patentinngrep* [Online]. Available: http://www.domstol.no/sa/Enkelt-domstol/Norgga-Alimusriekti/Avgjorelser/Avgjorelser-2009/Sporsmal-om-en-forskninsstiftelse-begikk-middelbart-patentinngrep/ [Accessed 01.12 2011].

EDQUIST, C. 2001. The Systems of Innovation Approach and Innovation Policy: An account of the state of the art. *DRUID Conference.* Aalborg.

EHRAT, M. 1997. *Kompetenzorientierte, analysegestützte Technologiestrategieerarbeitung.* University of St.Gallen.

ETZKOWITZ, H. 1998. The norms of entrepreneurial science: cognitive effects of the new university-industry linkages. *Research Policy* 823-833.

GATES, B. 1991. Challenges and Strategy Memo. Available: http://www.anonymous-insider.net/windows/research/1991/0717.html.

GEIGER, R. L. 2010. University supply and corporate demand for academic research. *Journal of Technology Transfer,* 37**,** 175 - 191.

GILLHAM, B. 2000. *Developing a questionnaire,* London, Continuum.

GREEN, J. 2012. Better Gas Mileage, Thanks to the Pentagon. Available: http://www.businessweek.com/articles/2012-05-17/better-gas-mileage-thanks-to-the-pentagon [Accessed 01.06.2012].

HALL, B., LINK, A. N. & SCOTT, J. T. 2000. Universities as research partners. *Review of Economics and Statistics,* 85**,** 485 - 491.

HALL, B. H., JAFFE, A. B. & TRAJTENBERG, M. 2001. The NBER patent citations data file: Lessons, insights and methodological tools. *NBER working paper, 8498*.

HARMAN, G. 2007. Research and scholarship. *International Handbook of Higher Education***,** 309 - 328.

HELLER, M. 1998. The Tradegy of the Anticommons: Property in the Transition from Marx to Markets. *Harvard Law Review,* 621.

HELLER, M. & EISENBERG, R. 1998. Can patents deter innovation? The anticommons in biomedical research. *Science,* 280.

HENDERSON, R., JAFFE, A. & TRAJTENBERG, M. 1998. Universities as a source of commerical technology: a detailed analysis of university patenting, 1965 - 1988. *Review of Economics and Statistics,* 80**,** 119-127.

HERJE, K. 20.04 2012. *RE: Telephone interview.* Type to TØGERSEN, S.-O.

HUANG, K. G.-L. 2006. *Innovation in the Life Sciences: the Impact of Intellectual Property Rights on Scientific Knowledge Diffusion.* PHD, MIT.

JAFFE, A. 1999. The U.S. Patent System in Transition: Policy Innovation and the Innovation Process. *NBER working paper, 7280*.

KALANJE, C. M. n.d. Role of Intellectual Property in Innovation and New Product Development. Available: http://www.wipo.int/sme/en/documents/ip_innovation_development.htm.

KOSTOFF, R. N. 1993. Semiquantitative Methods for Research Impact Assessment. *Technological forecasting and social change*, 231 - 244.

KREMER, M. 1997. Patent Buy-Outs: A mechanism for Encouraging Innovation. *Quarterly Journal of Economics*, 1137 - 1167.

LANJOUW, J. & SCHANKERMAN, M. 2001. Characteristics of patent litigation: A window on competition. *RAND Journal of Economics,* 32, 129 - 151.

LEMLEY, M. 2001. Rational ignorance at the patent office. *Northwestern University Law Review,* 95, 1497 - 1532.

LEONARD-BARTON, D. 1995. *Wellsprings of Knowledge: Buildin and Sustaining the Sources of Innovation,* Boston, Harvard Business School Press.

LERNER, J. 2002. Patent protection and innovation over 150 years. *NBER working Paper, 8977*.

LEVIN, R., KLEVORIVK, A., NELSON, R. & WINTER, S. 1987. Appropriating the returns from industrial R&D. *Brookings Papers Econom*, 783-831.

LIBARKIN, J. C. & KURDZIEL, J. P. 2002. Research Methodologies in Science Education: The Qualitative-Quantitative Debate. *Journal of Geoscience Education,* 50, 78 - 86.

LINK, A. N. & SCOTT, T. J. 2005. Universities as partners in U.S. research joint ventures. *Research Policy,* 34, 385 - 393.

LOWENSOHN, J. 2011. A Motorola lawsuit primer. Available: http://news.cnet.com/8301-13578_3-20092728-38/a-motorola-lawsuit-primer-infographic/ [Accessed 05.02.2012].

MAZZOLENI, R. & NELSON, R. R. 1998. Economic theories about the benefits and costs of patents. *Journal of economic Issues,* 32, 1031-1052.

MERTON, FISKE & KENDALL 1990. *The focused interview: A manual of problems and procedyres,* New york, Free press.

MILES, M. B. & HUBERMAN, A. M. 1994. *Qualitative Data Analysis: An expanded Sourcebook,* Saga Publications, inc.

MULDER, H. n.d. Newton and Hooke. Available: http://www.scienceandyou.org/articles/ess_14.shtml.

MURRAY, F. & STERN, S. 2005. Do formal intellectual Property Rights Hinder Free Flow of Scientific Knowledge? An empirical Test of the anti-Commons Hypothesis, . *NBER Working paper, 11465*.

NATIONAL RESEARCH COUNCIL (US) 2006. *Reaping the benefits of Genomic and Proteomic Research,* Washington DC, The National Academies Press.

NED DAVIES RESEARCH. 2011. *Ned Davies Research* [Online]. Available: www.ndr.com [Accessed 10.15 2011].

NELSON, R. R. 1959. The Simple Economics of Basic Scientific Research. *Journal of Political Economy 67(3)*, 297-306.

NELSON, R. R. 2004. The market economy, and the scientific commons. . *Research Policy,* 33**,** 455-471.

NORWEGIAN GOVERNMENT. 2011. Stortingsmelding om immaterielle rettigheter. Available: http://www.regjeringen.no/nb/dep/nhd/aktuelt/nyheter/2011/stortingsmelding-om-immaterielle-rettigh.html?id=654931.

OKAMURO, H. & NISHIMURA, J. 2012. Impact of university intellectual property policy on the performance of university-industry research collaboration. *Journal of Technology Transfer*.

ON THE COMMONS. 2012. *About the commons* [Online]. Available: http://onthecommons.org/about-commons [Accessed 23.05 2012].

PATENTSTYRET. 2012. *Patentregister* [Online]. Available: https://dbsearch2.patentstyret.no/ [Accessed 17.05 2012].

PEETERS, C. & POTTERIE, B. V. P. D. L. (eds.) 2006. *Economic and Management Perspectives on Intellectual Property Rights,* New york: Palgrave Macmillan.

PERELMAN, M. 2003. The Political Economy of Intellectual Property. *Montly Review,* 54.

POPOV, V. 2011. Do We Need to Protect Intellectual Property Rights? *CEFIR / NES Working Paper series, 161*.

PRAY, C. E. & NASEEM, A. 2005. Intellectual property rights on research tolls: Incentives or barriers to innovation? Case studies of rice genomics and plant transformation technologies. *The journal of agrobiotechnology management & economics,* 8**,** Article 7.

SAKAKIBARA & BRANSLETTER 2001. Do Stronger Patents Induce more Innovation? Evidence from the 1988 japanese Patent Law Reforms. *The Rand Journal of Economics,* 32**,** 77-100.

SCOTCHMER, S. 1996. Protecting early innovators: Should second-generation products be patentable? *The Rand Journal of Economics,* 27**,** 322 - 331.

SINTEF. 2012. *Historie* [Online]. Available: http://www.sintef.no/Om-oss/Historie/ [Accessed 14.04 2012].

STOKES, D. 1997. *Pasteur's Quadrant: basic science and technological innovation,* Washington D.C., The Brookings Institution.

THE EUROPEAN COMMISSION 2003. The role of the universities in the Europe of knowledge. Brussels.

THE RESEARCH COUNCIL OF NORWAY. 2012a. *The Research Council of Norway* [Online]. Available: http://www.forskningsradet.no/en/Home_page/1177315753906 [Accessed 18.05 2012].

THE RESEARCH COUNCIL OF NORWAY. 2012b. *The Research Council of Norway's grants distributed on research programs* [Online]. Available: http://www.forskningsradet.no/no/Nokkeltal/1138785797239 [Accessed 31.05 2012].

TRAJTENBERG, M., HENDERSON, R. & JAFFE, A. 1997. University versus corporate patents: A window on the basicness of invention. *Econ. Innov. New Techn.* , 5**,** 19 - 50.

TVEDT, M. W. 2012. Hvem skal eie forskningen? *Dagsavisen.no* [Online]. Available: http://www.dagsavisen.no/nyemeninger/alle_meninger/cat1003/subcat1011/thread243722/#post_243722 [Accessed 06.05.12].

VERSPAGEN, B. 2006. University Research, intellectual property rights and european innovation systems. *Journal of economic surveys,* 20**,** 607 - 632.

VEUGELERS, R. & CASSIMAN, B. 2005. R&D cooperation between firms and universities: Some empirical evidence from Belgian manufacturing. *Journal of Technology Transfer,* 26**,** 59-72.

WTO. n.d. *Understanding the WTO: The Agreements, Intellectual property: protection and enforcements* [Online]. Available: http://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm7_e.htm [Accessed 23.05 2012].

WYATT, E. 2011. Fight Backlog in Patents, Senate Approves Overhaul. *New York Times* [Online]. Available: http://www.nytimes.com/2011/09/09/business/senate-approves-overhaul-of-patent-system.html?_r=2&scp=2&sq=patents&st=cse [Accessed 16.02.2012].

YIN, R. K. 2009. *Case Study Research: Design and Methods,* Thousand Oaks, Sage inc.