

Review of University Patenting in Europe

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Abbreviations: TTOs, PP, IPR, PROs, EU, OECD,

1. Introduction

European Union has adopted the goal of becoming the most competitive and dynamic knowledge-based society in the world. Accordingly, in the Communication Towards a European Research Area (ERA), the importance of developing effective tools for the protection of intellectual assets is important to the competitiveness of most organizations, private or public, and to their attractiveness for investors has been endorsed. In particular, there is a need for properly balanced intellectual property (IP) systems, offering suitable incentives to innovate and invest in research, while at the same time ensuring that the diffusion and further development of research results are not stifled. In addition, actions are needed to promote the optimal use of intellectual property rights (IPR) systems in Europe, with a special emphasis on universities and smaller businesses. Universities have been increasingly encouraged to manage the inventions produced by their scientists in order to produce commercial outcomes like patents, licenses and start-up companies.

The ownership of IP model at the universities is deemed to be a strategic tool to leverage universities' ability to improve the commercialization of academic research results. In Europe the levels of university patenting and start-ups have been claimed to be low compared to the relatively high level of investment in universities or in public research organizations (PROs). This phenomenon has been developed in parallel to the European Paradox; according to which European countries have a strong science base but are not good at commercializing research results in the forms new technologies (EC Reports). This view is further exacerbated by the impression that universities in the U.S. have performed much better in commercializing their research results due to the Bayh-Dole Act.

Unlike the Bayh-Dole Act of the U.S., some European countries have dual IPR systems. Ownership of IP belongs to the employer at the PROs while according to the *Professor's Privilege* university researchers have the right to retain the ownership rights to their inventions. Sweden and Italy have a system of professor's privilege (individual ownership). Among others Denmark, Germany, Austria, Finland have abolished the Law of Professor's Privilege and adopted organizational (university) ownership of IP. Some other countries like France, UK and Spain have always an organizational ownership model. Many European countries whether having organizational or individual ownership have encouraged universities to establish TTOs with the expectation of a better protection and

governance of IP at universities.

Many scholars on the other hand criticized such initiatives and legislative changes have been done on the basis of, often anecdotal, empirical evidence that European Universities are lagging behind in technology transfer and almost generating “no patents” at all (Verspagen, 2006). They investigated the extent and patterns of patenting activities at European universities where the system of individual ownership is or used to be the customary model. They reached to a conclusion that European universities have been active in patenting and did not need to change the ownership of IP in favor of universities.

In this Chapter we review and bring together the findings of empirical literature on university patenting in Europe. As such, we are not aiming to give an exhaustive review or reassessment of these studies, but rather to provide a starting point to discuss the strengths as well as shortcomings of ownership of university IP in Europe in a comparative way, as long as the prior studies inform us. In Section 2, we review the changes in patent legislations at European universities and highlight the differences. In Section 3, we integrate the results of the empirical work on the extent and ownership patterns of university patenting in Europe. We discuss the contradictory aspects of legislative changes at the universities; focusing first on the pro side- i.e. direct utilization of university research results as patents by firms. We then discuss the con side- i.e. pre-emption of university inventions by incumbent firms. We also reflect why the roles of TTOs are still negligible and start-ups are rare at European Universities. In the concluding section we present some implications for university administrators and policy makers.

2. Ownership of Patents at European Universities and Legislative Changes

A key issue that is important for university industry technology transfer is the clarity of the ownership of IP. The ownership of IP at the European universities varies to a certain degree. As detailed in Figure 1, two models of IPR regimes, *Professor's Privilege (individual ownership)* and *Organizational (university ownership)* can be distinguished. In this section we present differences and commonalities in national legislations of IPR at the universities.

2.1 From Professor's Privilege to University Ownership

Both Sweden and Italy have individual ownership model despite some national differences. *Sweden* is the only Nordic country that keeps Professor's Privilege allowing university researchers to retain the IPR to their research results. Sweden has also established TTOs, university holding companies and other regional technology transfer agents in order to guide and help university scientists in their entrepreneurial endeavors. Sweden has enshrined in legislation the third task of universities to initiate and contribute to commercial activities, support economic and social development besides education and research, universities. Although this mandate has been expressed in more general terms that refer to general interaction with, and communication of research results to the broader society (Jacob et al., 2003).

Italy on the other hand introduced a system of individual ownership in 2001, unlike many other European countries. The main argument is individual scientists may have a greater incentive to patent than the universities that employ them. However the law has been criticized for placing responsibility of exploiting the invention, and the cost of patenting, on researchers who may not have the necessary expertise or funds to do so. In 2005 the rules have been revised again and the title of all the invention coming from externally funded research, and developed within a public institute, given to the organization, leaving to the researcher the possibility of a title only for research funded by the intra-institution source. It also encouraged the formation of technology transfer infrastructure at the

universities. Although it is not a duty for scientists to inform the university about their inventions, university scientists are encouraged to use the services of TTOs offered by the employing university.

Two national systems have yet some fundamental differences despite both of them are classified under the Professor's Privilege regime. Inclusion of specific rights given to the industrial firms especially in collaborative research where ownership rights can be vested in the partner companies, and university scientists' privilege will be revoked. Such specific regulations and unwritten enforcements may qualify the regimes in both countries as "*Quasi Professor's Privilege*" rather than the traditional understanding associated with Professor's Privilege.

Due to the fragmented picture on IPR regimes EU encouraged the adoption of organizational ownership model in order to streamline and harmonize the national regulations among the member states. European Commission's Green Paper on ERA stated that "*...the inconsistent and often inadequate rules and approaches for managing IPR resulting from public funding as a major hindrance to the creation of the ERA. The Committee also found that the development of a European charter for the handling of IP from public research and higher education institutes could make a significant contribution to shaping the ERA and to promoting cooperation networks...*" This legislative shift for organizational ownership has been partly motivated by the dramatic increase of university patenting in the aftermath of the Bayh-Dole Act. Although the effects of the Bayh-Dole Act are far from definite and conclusive, universities have been increasingly protecting their inventions – from genetic discoveries to software programs– with the expectation of generating additional funds for research as well as formation of new ventures. Inspired partly by the harmonization policies of the EU and partly due to the success of Bayh-Dole Act a number of countries have abolished the Law of Professor's Privilege and adopted various models of institutional ownership, which grants the ownership of IP resulting from publicly-funded research to the institution and not to the researchers have been adopted.

Denmark introduced the Act on Inventions at Universities, PROs and hospitals effective as of 1 January 2000. Among other things, the law permits research institutions to take over rights to inventions made by their employees, and obliges the institutions to try to commercialize the inventions they have taken over.

German Government reformed a section of German employer-employee law dealing with inventions by teaching faculty at universities. In 2002 the ownership of IP within HEI are transferred to the employing organizations, though researchers will retain rights to receive two-thirds of any licensing or other income from their invention (OECD, 2003). A federal program starting 2002 was set to promote the commercialization of university research through the creation of Patent Marketing Agencies.

Austria introduced Patents Act in 2002 according to which inventions made at a university in the course of federal employment or training, shall be owned by the employing university. A Governmental technology transfer organization Tecma is in charge of patent exploitation and supports researchers and companies in marketing promising innovations.

Norway also abolished the individual ownership of IP at universities in 2003. The right to ownership of IP is vested with the employing organization. TTOs were also being established at the Norwegian universities based on government funding. A division of income accruing from commercialization with one-third each to the individual scientist(s), the department and the institution was suggested.

Finland has also introduced university ownership with effect from 2007. A distinction is made between open research and collaborative research. The universities entitled to acquire the rights to the

invention that is made in collaborative research within six months from the disclosure of the invention. When the university has acquired rights in the invention, the inventor will be entitled to obtain reasonable compensation for the invention.

The university also has the competence to make contractual arrangements with third parties concerning patentable inventions that may be made within research projects. The entitlement to inventions resulting from open research will remain with the inventor. Such inventions, however, are covered by the duty to inform the university about the invention.

In Eastern and Central European Countries (Hungary, Poland, Estonia, Lithuania, Slovenia, Slovak Republic) the first owner of the IPR created by an employee in the course of their employment is the employer (university) unless the employment agreement states otherwise.

Some European countries having already organizational ownership model advised universities to establish TTOs and play a more active role in commercializing the research results.

In the *UK* universities generally own the IP generated by their academics. In 1948, the British government set up the National Research Development Corporation (NRDC) to commercialize publicly funded research in Britain. Most universities are able to undertake the full range of technology commercialization activities in their own name they nevertheless structure their TTOs and implement the organizational ownership model differently (Geuna and Rossi, 2011).

In *Belgium*, in the Flanders Region, all IPR from university researchers belong to university. Since 1998 universities in the Walloon Region can also own the results of research that is fully funded by the region.

In the *Netherlands*, if the invention is made by an employee of a university or PRO the employer is entitled to the patent. Patent applications have become responsibility of the universities, as is their funding. A number of universities have consequently set up a patent fund, which is sometimes maintained through the proceeds from earlier patents.

In *France*, the legislation is quite general. Universities and PROs are considered as employers, which will own the rights on inventions made by staff. Revenues resulting from patent licensing are shared in equal parts between the university, the department, which sponsored the research, and the team of researchers and professors who produced the invention (Cesaroni and Picaluga, 2005).

Spain has also organizational ownership model. The 1986 Law for the Promotion and General Coordination of Scientific and Technological Research required universities to become better aligned to societal needs and economic development in particular, and stated that universities and RROs retained ownership of their research results (Azagra-Caro, 2010).

In *Portugal*, in the case of university professors the provisions of IPR ownership set out in law will generally deem the employing university as the owner (EC, 2009). The department for which the researcher is working and the researcher or research team jointly owns inventions resulting from public research

Greece has an organizational ownership model as well. In Greece separate provisions apply depending on whether an invention is a “service invention”, which is automatically owned by the employer, or, a “dependent invention”, which is owned by the employee, unless taken up by the employer.

2.2 Quasi University Ownership

Although there has been a clear trend for university ownership of patents, in practice the European modeling of the Bayh-Dole Act differs from the USA. In some European countries, e.g. France, U.K., Latvia, Estonia and Ireland the legislation grants the university/PRO as the first and the “*automatic owner*” of the IPR. They are not usually any reversion rights to the employee inventor and whether the employee inventor is entitled to compensation for transferring the invention varies among the countries. Some countries on the other hand, e.g. Austria, Finland, Germany, Hungary and Lithuania, introduced the principle of “*Pre-emption Rights*”. According to this principle the researcher is the first owner of the invention but the university or the PRO has the right to claim the invention most usually within a specified period. In the event that the invention is not claimed within the specified period (e.g. 2 and 6 months from notification in Belgium it is up to 3 years), then generally the right to the invention reverts to the inventor scientists. However such practice may prevent the accumulation of a body of IP by university, which can be bundled and re-utilised later for academic and/or commercial purposes. In the case of commercialization, in most of these pre-emption rights systems, the employer must pay some form of remuneration to the employee inventor as compensation for transferring the right to patent the invention to the employer.

There are also exceptions for inventions made by researchers in their own time using their equipment or for inventions made within the framework of collaborative or sponsored research (EC, 2009). Under the Finnish, German, Greek, Hungarian legislations, if the invention is classified as “*free, open, employee, dependent*” the ownership could be vested in the inventor (scientists) almost according to “Professor’s Privilege”. Only if the research behind the invention is done as a part of the employment contract which is an invention created by a person who has an obligation under his/her employment to develop solutions that fall within the sphere of the invention and an defined/expected as a part of the job at the employing organization) the rights are vested in the university/PROs (EC, 2009).

If the research is partly funded by industry or another party (e.g. in university-industry competence centers or in industry sponsored projects) specific arrangement are generally signed between university and industrial partner(s) at the beginning of the project. These special contracts often grants “*right of first refusal*” to the firms. In most cases the results will be owned by the grantee of the funds unless the grant agreement or IP laws state otherwise. In the aftermath of the reform of the university employee law in Germany, a general agreement, a.k.a the “*Berlin Contract*” has been signed in which university representatives (TTO experts from Berlin Universities) and industry representatives (large companies like BASF, Bosch, DaimlerChrysler, Schering) agreed on structuring the IP ownership in research cooperation/commission or contract research. Depending on the nature of contract, all results may belong to the industrial partner(s) with or without any additional remuneration to the university. Industrial partner(s) will also decide whether to file any applications for any industrial property rights exclusively in its own name, to engage in exploitation or development (Goddard, 2005). Similar to Berlin Contract, most European universities have been given the autonomy allowing them to devise by-laws that apply to the management of knowledge transfer issues. These contracts are giving pre-emption rights to the industrial partners and funders despite the organizational ownership of IP at the universities. In the making of the Bayh-Dole Act a coalition emerged between the universities and small business but left big business out, allaying concerns that patents could contribute to monopolization. However in the Berlin Contract and other similar agreements were drafted in consultation with large firms which also granted pre-empting rights to the firms.

Depending on the type of research and contract with the industrial partners the European version of organizational ownership model can be quite different from the US model. It is our impression that European countries moved rather from the professor’s privilege to a firm’s privilege model. It is misleading to conclude that European countries have emulated the Bayh-Dole Act per se (Geuna and

Rossi, 2011). In the next section we review the emerging data on university patenting in some European countries and then discuss the strengths and shortcomings of the IPR regimes in Europe.

3. Evidence from University Patents

3.1. University-owned versus university-invented Patents

University patenting is not the exclusive domain of US universities. Most information on university patents comes from surveys submitted to university administration or to newly established TTOs, or through cursory searches for the names of universities or university TTOs as the applicants for patents. Until recently there have not been reliable data on the amount of university patents where individual ownership of IP has been a common practice. Depending on either individual or organizational ownership of IP scientists can apply for patents individually. Alternatively university-inventors may assign their rights to another party to apply for a patent with the aid of TTOs or through other actors such as firms. Due to the different institutional and organizational set-ups at European universities, a number of scholars have identified the names of university scientists who have been registered as inventors in patent databases rather than searching for university names or TTOs as applicants of patents. They constructed university patent datasets. Some of these datasets on university-invented versus university-owned patents fail to capture all patents invented by academic scientists who retired or moved out of the university system thus were not found in the university records; or some of them fail to confirm if a university researcher is an inventor when in fact two have the same names. Moreover as different time periods or patent databases are a direct cross-country comparison will be limited. We are also aware that these studies are based on data and observations from different European universities with different university systems and national systems of innovation. This implies that caution must be taken in interpreting results from one national context to another and in drawing broad, general conclusions. Despite these limitations we can nonetheless draw a number of emerging conclusions and promising avenues for further research that emanate from these studies.

Meyer and his collaborators in a series of studies used a matching procedure between first and family names of inventors in patent databases and university researcher registers. They matched all USPTO patents that had at least one Finnish inventor for the period 1986 to 2000 with the names of university researchers that were employed at Finnish universities in the years 1997 and 2000. Meyer et al. (2003) reported that Finnish universities owned 36 USPTO patents that had at least one Finnish inventor, while university-invented patents amounted to 530. In his study of Flemish universities, Meyer et al. (2005) found that there were 379 university-invented patents compared to 100 university-owned patents at Flemish universities.

Balconi et al. (2004) found that out of 1,475 university-invented patents in Italy between 1978 and 1999, only 40 EPO patents had universities as applicants, whereas Italian university-inventor patents account for 3.8 per cent of EPO patents by Italian inventors.

Azagra-Caro et al. (2006) pointed out that although French universities are legally entitled to own patents based on scientists' research results, the university-invented, but not university-owned, patent has been and remains in practice the most common form of patenting at the University Louis Pasteur in France. From 1993 to 2000 they found 463 patents related to the university. Of these, only 62 patents were owned by the university.

Giuri et al. (2006) showed that the total number of university patents in the PatVal survey of inventors for six European countries (Germany, France, Italy, The Netherlands, Spain and the UK) was 433. The PatVal survey was addressed to inventors listed on (granted) European patents with a priority date in the period of 1993–1997. The survey obtained responses relating to 9,017 patents representing

18% of all granted EPO patents with a priority date in the considered period. Out of 9,017 patents, 433 patents, which were identified as university patents, have at least one inventor who was employed by a university. Crespi et al. (2007) further investigated the 433 university-patents in the Patval survey and found that much of the university research that leads to patents in Europe does not show up in the statistics, because it is private firms rather than the universities themselves that apply for the patent. About 80 percent of the EPO patents, which have at least one academic inventor, are not owned by the university.

Iversen et al. (2007) found that a total of 569 researchers from Norwegian public research organizations were involved in at least one patent application in the years between 1998 and 2003. These researchers were involved in 10 to 11 percent of domestic patent applications during those years. The contribution of university researchers was high in chemical and pharmaceutical patenting, accounting for nearly 18 percent.

Göktepe (2008) showed that a total of 458 patents were identified as the Lund University patents in Sweden, and 250 university researchers were identified as inventors in the EPO patent database (between 1990 and 2004). University patents account for about 2 percent of the total number of national patents between September 1990 and September 2004.

Based on the KEINS database Lissoni et al. (2008) found that the university professors, who were active in Sweden and Italy during 2004 and in France during 2005, were responsible for a substantial number of patent applications during the period between 1978 and 2002. During that period there were 2,800 patent applications in France, 2,200 in Italy and 1,400 in Sweden. Lissoni et al. (2007) compared the level of patenting in these three countries (between 1994 and 2001) with the US university patent data (between 1993 and 2000). They found that French, Italian and Swedish university-owned patents constituted less than 1 percent of the total number of domestic patents. The proportions of university-invented patents are around 3 percent in France, 4 per cent in Italy and more than 6 percent in Sweden. US estimates for university-invented patents are about 6 percent (Thursby et al., 2006). Lissoni et al. (2008) have also shown that the gap between the US and Europe in terms of university patenting turns out to be a very limited gap between the US and France and Italy, and no gap at all between the US and Sweden.

In their follow-up study for Denmark, Lissoni et al. (2009) identified 306 Danish academic-inventors among the 7395 professors who were active in 2001, 2004 and 2005. They found 495 patents that have at least one professor as an inventor of the patent.

The existence of university-invented but not owned patents has been also observed in the US, yet to a lesser extent. Thursby et al. (2007) found that 26 percent of the patents are assigned solely to firms rather than to the faculty member's university as is dictated by US university employment policies or the Bayh Dole Act. Patents assigned to firms (whether established or start-ups with inventor as principal) are less basic than those assigned to universities suggesting these patents result from faculty consulting. Audretsch and Aldridge (2010) also found that 70 percent of faculty chose to commercialize their research by assigning all patents to their university transfer offices (TTO) while 30 percent chose a "backdoor route" to commercialization and did not assign at least some of their patents to the university TTO.

The prior studies showed the methodology of finding the university inventors by matching them with the inventors in patent databases, gives a better picture of the extent of university patenting in Europe. The new patent datasets provide evidence that the *number of university-invented patents is much higher than the number of university-owned patents*. Before these studies, university patents were often understood as patents assigned to universities, and the patenting activities of university

researchers were more or less invisible for European universities (Cesaroni and Piccaluga, 2002; Saragossi and von Pottelsberghe de la Potterie, 2003). These emerging datasets suggests that the European academic system seems to perform much better than had been believed until now.

In relative terms, European universities' patenting output lags only marginally behind that of US universities (Crespi et al., 2007). European Paradox might not necessarily be true as the differences in the amount of university patents can be explained by the differences in legislations. Despite the importance of Bayh-Dole Act in fostering technology transfer in the US; different national innovation systems may require different solutions. The economic implications of institutions like Bayh-Dole and technology transfer offices are overestimated. Consequently the abolishment of the professor's privilege has been argued to be unnecessary and futile. Scholars concluded that European universities do not need to emulate the Bayh-Dole Act in order to increase university patenting. However, the question is no longer if and/or how much European universities produced patents or if Europe needed to emulate Bayh-Dole Act, but rather who owns the university patents and how the ownership may affect the nature of research and innovation activities at universities.

3.2. Seamless Web between Scientists and Firms

Following academic patents to their owners/applicants gives us an idea about the extent to where academic inventions are utilized. Scientist-inventors at the European Universities can/could choose different routes to commercialize their research results. They may patent individually, patent through TTOs, or patent through with industrial firms. They can/could directly transfer research results to firms which they are collaborating or have contacts with. As such the system prevents losing time for searching during the negotiation process without informing university administration and/or TTOs. Following this clue, we expect the Professor's Privilege may have some positive implications on university industry relations. It has facilitated more or less direct technology transfer between scientists and firms, and even forged collaboration between scientists and firms.

According to KEINS database in all of the three European countries (France, Italy and Sweden), university administrations have much less control over professors' IPRs than in the US. In Sweden, where the professor's privilege is still standing, academic scientists often patent in their own name. 60 percent of academic patents in France are owned by business companies. 74 percent of Italian academic patents and 82 percent of Swedish ones are owned by firms, in contrast, business companies own only 24 percent of US academic patents. Conversely, universities in three European countries own a very small share of academic patents: around 8% in France and Italy and less than 4 percent of Swedish ones, well below the 69 percent owned by the US universities (Lissoni et al., 2008). Almost 70 percent of Danish university patents at the EPO are owned by firms while 12 percent of patents are filed by universities. The scientist-inventors file 12 percent of patents and governmental agencies account for less than 3 percent of university patents (Lissoni et al., 2009).

In KEINS database, business companies own almost 80% of academic patents in Electronics & Electrical Engineering. Both in Italy and in France, large state-controlled companies (such as ST-Microelectronics, ENI, France Telecom, and Tales) hold a very large number of academic patents. Large multinational companies (Ericsson and ABB) are also the important owners of the Swedish academic patents. Lissoni et al. (2009) found that the largest amount of academic patents in Denmark is owned by the most important pharmaceutical company NovaNordisk (including Novazymes). In all of these countries, only one university is among the top patent holders (i.e. the country's largest universities of Rome-La Sapienza in Italy; Paris 6 in France and Karolinska Institute in Sweden and Copenhagen University in Denmark).

Like other European countries in Germany, university-owned patents are found to be relatively rare, but university-invented patents have been increasing continuously from less than 200 in the early

1970s to around 1,800 in 2000 (Meyer-Krahmer and Schmoch, 1998). Czarnitzki et al. (2007, 2008) found relatively low number of German university patents. Grimpe and Hussinger (2008) argued university licensing is used by a few German firms, instead, consulting and informal collaboration have been shown to be substantial. Authors assumed that university scientists in Germany, and especially highly credentialed faculty members, should be more likely to engage in informal technology transfer than their U.S. counterparts. Grimpe and Fier (2009) assumed that the specific German orientation toward excellence in engineering plays a role for the informal technology transfer behavior even several years have passed since the abolishment of the professor's privilege in Germany. Authors emphasized that engineering research is organized in large research groups, with multi-million research funding and close collaboration with industry. Both bonds through their alma mater and the network provided by the German Engineers Association facilitate informal technology transfer activities.

Meyer (2003) also found that that *most of the university-related patents appear to be assigned to large companies*. Mostly large firms are engaged in patent-based collaboration with university researchers. At the aggregate level for all universities, Nokia is the top assignee with 10.7 percent of the total amount of patents. Orion Corporation follows with 6.8 percent of all patents, closely followed by Valmet with 6.6 percent. The top three assignees account for a share of 24.1 percent compared to all patents.

Firms are also the main owners of Lund University-patents that were applied during 1990 and 2004. In all, 117 firms applied for 363 patents. This constituted 79.3 percent of all patents. Inventors applied for 12.9 percent of all patents, or 59 out of 458 patents. These patents were not assigned to any company at the time of application. Inventors most probably transfer (license, sell or give) their patents to firms later. In total, 11 different TTOs located within the university, region or outside of Sweden applied for 36 patents out of 458. TTO patents constituted 7.9 percent of all university-patents. Any IP emanating from university-industry collaboration have been transferred automatically to partner companies in return for further research funding and collaboration. Yet these results are not recorded as invention disclosures to universities or patent applications by the universities.

At Lund University, large firms accounted for 57.6 percent of the patent applications; they applied for 209 of the 363 patents for which applications were submitted by firms. 27 SMEs applied for 51 patents while 58 spin-offs applied for 103 patents. These spin-off firms were started by either former or current academics and they maintained close relations with the department or research group they spun-of. Some spin-off firms have for instance employed students from the research group. Although the absolute number of university spin-offs (58) is almost the double the number of large established firms (32), patents applied for large companies is twice as much as patents owned by spin-offs. There are 105 patents in ICT and telecom-related fields. Of these ICT and telecom related patents, 80 were applied for by Sweden's largest telecom company, Ericsson. Likewise most of the patents in pharmaceuticals were also applied for by one large firm AstraZeneca. In sectors such as mechanics, materials and biotechnology, there were more SMEs and spin-off firms as patent applicants. In biotechnology and related fields, 39 patents were applied for by the 19 spin-off firms, and 14 SMEs applied for 24 patents. In materials and related fields, 17 patents were applied for by 4 spin-off firms.

Ericsson, ABB, AstraZeneca, and Gambro AB are the key applicants of the Lund University related patents. A few start-ups, Obducat AB, Amersham AB, Bioinvent AB are the applicants of the Lund University patents. These figures reflect the dominance of large firms in the Swedish economy and their relatively easier access to university knowledge. Universities and scientists are often trying to keep good relations with the companies in order to have a steady flow of research contracts, funds, and materials as well as to have job options for their students. Industry typically support research at

the universities, and pays for the cost of the patent application and maintenance costs and owns the patent, yet scientists behind the novel idea recorded as the inventors.

We have derived the following observations. Research funding constraints have been forcing many scientists to seek for external collaboration. At the same time, many industrial firms rely more on collaborative research with universities instead of conducting basic research in their own laboratories, or consulting university scientists to solve their problems. Knowledge that is co-developed and results transferred directly to the existing firms. The partner firms have the *rights of first refusal* for the inventions that are generated in collaborative projects or sponsored research. Research results are disclosed to the partner firms and interested partner firms may apply for the patent.

As emphasized by the scientists who are involved in collaborative arrangements with firms, Professor's Privilege facilitates the relations with industrial partners, since scientists can easily transfer the ownership rights of their intellectual property to the partner firms, without the intervention of TTOs. Patents will be directly transferred to industrial partner without unnecessarily waiting for a TTO or a patent attorney to evaluate and apply for a patent. Less or no time is wasted for searching for firms that are interested in the technology or for the negotiation process with the firms for licensing and other contracts. Many of the Swedish scientists considered that it is quite risky that universities in an effort to increase amount of university-owned patents and licensing revenues may mismanage IPR negotiations with industry. The intervention of university TTOs may raise time and costs of transferring knowledge to firms and may damage existing terms of collaboration.

University–industry collaboration facilitated via competence centers or joint projects may have even enabled Europe's established companies to solve their problems and improve their innovation capacities. Research groups and scientists often engage in competence centers or joint projects with several companies from within the same industry or complementary industries. Different firms may benefit different aspects of knowledge and research results rather than a single firm appropriates exclusively. Like Japanese universities (Kneller, 2007) many European universities have good researchers but weak TTOs. Steady relations and collaboration with industry are the only effective mechanism of technology transfer – at least if start-up formation is not feasible because of lack of venture capital, management expertise and markets.

The relationship between scientists and firms are reciprocal. Inventor-scientists reported collaborating with firms lead more quickly to deeper scientific understanding and developments. Many scientists found interacting with industry useful as it often deals with a real industrial problem with social and economic relevance. Professor's privilege also brings some elasticity in the European university system where salary structures and career paths can be quite rigid by rewarding individual efforts and networks. Scientists have benefited by signaling their knowledge and skills by showing their excellence and relevance of their research and attract further industrial funding. As a matter of fact such scientists managed to attract governmental funding as well where industrial relevance and utilization have become assessment criteria.

Prolific scientists have established long-term relations mainly with the national incumbent companies. For instance most academic inventors at Lund University collaborated with Swedish industrial corporations like Ericsson, ABB and Volvo. And much of the funding comes directly from these industrial partners in return for the ownership of any intellectual property resulting from the project. One of the inventors we interviewed from the Faculty of Engineering who is working closely with the Swedish automobile industry commented that: *“he and his colleagues are not interested in being listed as inventors, as this does not give any kind of merit.”*

Such academic inventors are mainly in the expectation of generating further research funds and create

job opportunities within the partner firms. They do not want to destroy the delicate bonds they or their supervisors worked hard to solidify, severely undermining their ability to secure further benefits they are expecting from their industrial partners. Most of them also swayed that it is quite unlikely that they can start-up a firm within their field. They expect partner companies will do further investment for product development and marketing which would have been difficult with the university resources and scientists' own skills and interest in commercialization.

3.3. Pre-emption of University Invention by Incumbents

We have thus far showed Professor's Privilege facilitated collaboration and technology transfer between university scientists and firms. However Professor's Privilege has its downsides. The emerging evidence on ownership of university patents indicate that big established firms have an upper hand position in deciding the nature and content of the research in joint projects with universities scientists. University research is skewed towards the interest of private companies. Such collaborative projects may cause a shift in focus from fundamental to applied research in universities. It thus also raise questions whether such projects have much narrower focus and results in narrower patents which are essentially solving the existing industrial problems. The analysis of German academic patents shows that academic patents that enable firms to reap short-term returns rather than possibly more uncertain long-term returns are most likely to be assigned to corporations. Firms also strive for academic inventions with a high blocking potential in technology markets. Academic patents issued to corporations appear to reflect less complex inventions as compared to inventions that are patented by the science sector. Likewise US faculty patents assigned to firms resulting from consultancy are found to be considerably more "incremental in nature" than are patents assigned to universities (Stephan, 2012).

Professor's Privilege and close informal relations with the existing firms as well as the formation of collaborative research programs between university and industry (like competence centers) lead to a tendency for a reverse linear model of innovation, where research questions have been designed in relevance to the industrial needs. Faculty consulting (collaborative) projects are therefore more incremental and leading to less complex patents than projects originating in university labs, which are of a more basic nature (Mansfeld, 1995 in Stephan, 2012, p. 56). Such research essentially contributes to the in-house research activities of existing firms, unlike research conducted independently from industry. The participant firms have almost exclusively owned patents resulting from such collaborative arrangements. This practice has dominated the nature of university research as well as pre-empted the university knowledge by a few dominant firms.

A few large companies have stronger influence than smaller firms and scientists on the research areas and they may obtain more than what actually they are supporting financially. Due to the Swedish industrial specialization, interactions, consultancy in the fields of medicine, chemistry, and engineering were quite common. Many large Swedish firms have for long time had strong connections with leading universities in Sweden (Stankiewicz, 1986; Etzkowitz et al., 2005). It is likely that most of the research results go through the grapevine, and have been taken in by existing companies. Like in Sweden in many other European countries, directly and indirectly, large multinational corporations tend to dominate nature and route of research activities at the universities. However these firms do not have the obligation to develop and utilize the patent, and generally they do not pay royalty fees back to the university or scientists except the fact that they may further collaborate with the scientists (as consultants) and may further sponsor research at the universities.

There may be even risks that many talented researchers fall into a routine of doing applied research for industry while ignoring fundamental issues that hold the keys to the next generation of new products (Kneller, 2007). Another concern would be professors who are collaborating individually with a single firm could also exclusively transfer all the research results and IPR to a

single company. As firms are co-owners by virtue of co-inventorship or as a result of the terms of the sponsored research contract, the company can block the transfer of the university's rights to any other company.

Another important question especially since the advent of the 'entrepreneurial university' (e.g. Etzkowitz *et al*, 2000), relates to the extent to which academic *inventiveness* translates into academic *entrepreneurship*. Meyer (2003) indicated that academics may have the capacity to act in an entrepreneurial style (certainly when securing research funding) but may have trouble becoming entrepreneurs in an environment where large companies have upper hand in the exploitation of university inventions. In Finland start-up companies are only ranking among the best three in very few instances in terms of using university inventions.

The prevalence of Professor's Privilege and the formation of collaborative research with firms, while helping established companies to develop competence in their fields or in new fields, may decrease the possibilities available for academic entrepreneurs utilize and start their firms. It is likely that the established firms have taken most interesting and commercially viable research results while more mediocre or embryonic research results would be left to the TTOs or to scientists. There will be little that TTOs or scientists can do to develop and commercialize such research results.

University scientists who are collaborating with firms learned the patenting process through their industrial contacts. Like in Germany many serial inventors are unwilling to accept the role and involvement of TTOs. They consider the intervention of TTOs as impractical and unnecessary since the firms they collaborate with are the entities that apply for the patents. Universities generally do not require corporate researchers engaged in collaborative research to transfer their rights as inventors or co-inventors to the university, even though the inventions may have arisen in university laboratories (Kneller, 2007). As in the USA, universities rarely assign the right to apply for patents on inventions arising under sponsored (commissioned or joint/collaborative) research agreements to industry partners. Rather, the universities offer the partners the right to negotiate an exclusive license to such inventions – to the university's portion when there are university and industry co-inventors. However, like in Japan, university patent reforms in Europe favors the industry partners in a way US patent law does not. Collaborating incumbent companies have the right of first refusal in joint research projects. The universities, often at the urging of the professor who wants to keep good relations with the company, usually agree. In such cases, the joint research sponsor typically pays a majority of the patent application and maintenance costs, but has no obligation to develop the invention to pay royalties to the university unless it licenses the invention to a third party (Kneller, 2007).

The university TTO, often at the urging of the professor who wants to keep good relations with the company, usually agrees. In such cases, the joint research sponsor typically pays a majority of the patent application and maintenance costs, but has no obligation to develop the invention to pay royalties to the university unless it licenses the invention to a third party. It is unlikely that those firms will allow TTOs or inventors to sell the patents resulting from their collaborative projects. In a situation like this, scientists, the university and all parties would lose. Some inventors have implied that if a change happens in the ownership of patents, that is, if scientists no longer own their patents, scientists may avoid invention disclosures; they may bypass the TTO, choose the "backdoor", or disclose fewer and/or mediocre ideas to the TTOs.

As such technology transfer infrastructure is preordained to be weak and futile. A weak TTO has some downsides as well. Some of researchers may not be interested in commercialisation or may not have the necessary skills, financial means and contacts to commercialize their research results either. Moreover as the costs of IP protection can be considerable high for an individual scientists or research group to bear, many scientists and research groups may simply give up pursuing IP protection. As a

result some new commercial opportunities may be lost due to lack of efficient technology transfer infrastructure.

Likewise in the absence of interest for further investment and development by an existing firm, some research results may be left underutilized. As it is unlikely that weak TTOs have the competence to exploit these results in the forms of start-up companies. Due to the dominance of large companies in the appropriation of university inventions start-ups are relatively weak and rare from European universities.

4. Concluding Remarks

The development of institutions and organizations at the national and university level to facilitate and govern innovation and entrepreneurship activities is complex where successful policy instruments in another national or organizational context may not have the desired implications. In this chapter we reviewed the implications of patent legislations at the universities in European countries.

We integrated the results of the prior work and summarize the extent and ownership patterns of university patenting in Europe. Although these datasets have some limitations and comparing one university or national system to another is difficult we derived some common patterns and trends for further research. In the light of this emerging evidence on university-invented patents, we found that the question is no longer if and/or how much European universities are producing patents or if Europe needed to emulate Bayh-Dole Act, but rather who owns the university patents and how the ownership may affect the research competence and technology transfer potential at the universities. We thus discuss the conflicting aspects of legislative changes at the universities, focusing first on the pro side- i.e. university-industry relations and patents are not uncommon in Europe even under the Professor's Privilege Regime. The emerging datasets on university-invented patents have shown that European scientists have been also producing a number of patents even under the system of Professor's Privilege.

Bayh-Dole Act was implicitly based on the assumption of a linear model of innovation, in which universities perform basic research with little concern for application and private firms invest in applied research and commercialization (Mowery et al., 2004). As such patent-based incentives and management of IP by universities are seen as essential to link universities, inventors and industry in the commercialization process. However the ownership of university inventions by the existing industry and the closer relations between industry and university scientists in Europe makes the modeling of Bayh-Dole Act in Europe is believed to be unnecessary.

We then discuss the con side, i.e. to what extent the law of Professor's Privilege may foster university inventions to be pre-empted by incumbent firms. It had even inhibited the flourishing of entrepreneurial culture among scientists.

Policymakers in Europe (as well as outside Europe) now see knowledge as a source of economic growth and aim to increase the commercialization of research results by changing the legislation of higher education and management of intellectual property rights, as well as the structure of research funding. These policy measures have been taken not only by the arguments that these new institutions and organizations can support and speed up the industrial exploitation of academic research but also the financial returns from commercial activities may help to support research and teaching at universities.

On the other hand another group of scholars criticized that such policy adoptions were made on the basis of the wrong presumption that European universities do not contribute enough to the production

of patentable technology.

We however argued that the policy discussions should be made not only on the basis of whether one system is producing patents or not. Although several studies found university-invented patents are much higher than the university-owned patents in the professor's privilege regime, implications of professor's privilege and the close informal or formal collaborative relations with industry are beyond the quantifiable number of patents. The debate over why European universities should not retain the IPRs over their scientists' inventions, or the weaker roles of TTOs can be partly explained by their dependence on their relationship with industry as well as with their own academic staff.

Overall it is our impression that much is unknown about the advantages and disadvantages of the European system of university patenting.

Most European governments (as well as other countries like Japan, India, China...) have pursued a set of policies aimed at directing funds at university patenting specifically and entrepreneurial activities in general. The effectiveness of these policies can largely be influenced by the incentives of university researchers to commercialize their ideas. Without attention to the research life offered by universities and particularly the extent to which it attracts researchers to stay at universities, politicians will devise incomplete policy solutions. These policy tools may neglect and even threaten the main sources of satisfaction and personal development that most researchers derive from their research environments. The system works best when incentives are spread rather than there being attempts by one actor to steer academic scientists in a particular direction. In spite of the difficulties in evaluating the impact of policy instruments a priori, it is clear that these problems alone cannot justify the untenable practice of developing and maintaining one-size-fits-all policy instruments.

In order to provide better answers to the question of the management of IPR at the universities one should look into the research activities from which the patents whose existence we have uncovered come from: Do they originate from research projects, whose results the universities prefer to leave in business partners' hands, possibly in exchange of a lump sum reward? Or do they originate from academic scientists' consultancy to business firms, which escape university administrations' control? How well /widely do these collaborative arrangements promote technology transfer? Are they economically viable for universities? What is the prevalence of collaborative research in various scientific fields? Do university-industry collaboration take only place in departments like biotechnology, nanotechnology, electronics, while departments of basic sciences are marginalized? □ What is the participation ratios of large versus small companies in collaborative research projects (like in competence centers)? How do IP is shared and utilized among the participants? What are the specific benefits of professor's privilege to junior researchers and students. The main purpose is to enable scientists and universities to produce scientific knowledge as well as industrially relevant knowledge in collaboration with firms. However as the policy learning in Europe has so far focused on the transfer of ownership from scientists to university (e.g. TTOs) caused negative reactions among scientists as well as corporate researchers who assumed the changes as a challenge to their existing relations.

The more we investigate the European cases the more we are forced to recognize that the observed patterns of university patenting in Europe depend much more on the institutional features of academic research and career plans as well as traditional relations with industry which are now forced through university-industry competence centers rather than on the success or failure of IPR reform and technology transfer policies.

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Appendix

Table 1: OWNERSHIP OF IP at European HEIs & PROs

