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# **Who should own university research?**

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in Sweden and Germany on the incentives  
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*Mark O. Sellenthin*



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## Foreword

Ownership of the rights to research findings is a widely debated and important issue. Not only does this relate to our view of the role and freedom of research, it also involves the linkage between our investments in research and their “output” in terms of innovations that can be commercialised.

This report compares the systems governing ownership rights in Sweden and Germany. The conclusions are that the question of ownership rights is not the only just as important that support structures for research are organised in such a way that the risks and costs connected with research and commercialisation can be managed and disseminated.

Mark O. Sellentin from Linköping University has been commissioned by ITPS to carry out this study. Professor Charles Edquist has co-ordinated the project. However, the author is solely responsible for the conclusions of the report. The project manager at ITPS has been Göran Hallin.

Östersund June 2004

**Sture Öberg,**  
Director-General



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## 1 Introduction<sup>1</sup>

Knowledge is the most important source of long-term economic growth. A substantial part of this knowledge takes the form of technologies associated with economic and social activities, such as the production and use of goods and services (Michie et al 2002, p. 253). The term “knowledge-based economy” is frequently used to describe the present form of capitalism in advanced countries. Not surprisingly, “as key sites both for research into new fields and for the training of future researchers and skilled personnel, universities and other higher education institutions have found themselves inevitably drawn into the modern national policy arena” (OECD 1999, p. 9).<sup>2</sup> But the university is a complex governance structure and different stakeholder hold different objectives. According to OECD (2003a, p. 7), “in addition to the scientific community, and the government as the main funder of the public research enterprise, the business sector and civil society in general have become more active stakeholders.” In particular, goals related to national competitiveness gain attention. “Governments’ main stakes are to seek greater efficiency in their research investment aimed at sustaining national capacities of knowledge production that can benefit society and provide spillovers in the economic sector” (ibid. p. 9). Even private industry is increasingly interested and involved in public research. “The business sector has become a more active stakeholder. Its increasing share in the funding of R&D performed in the public research institutions reflects its growing involvement in knowledge production” (ibid, p. 9).

But even if universities are increasingly regarded as “important engines of technological development and economic growth” (Klofsten & Jones-Evans 2000, p. 299), the share of governmental funds to universities is declining in the advanced countries in the last two decades (Geuna 2001, p. 614).<sup>3</sup> Universities are expected to interact more frequently with private industry and to adapt more to its needs.<sup>4</sup> As a consequence, knowledge and technology transfer from university to industry is frequently regarded as a panacea to solve a number of economic problems.<sup>5</sup> First, technology transfer is a means to exploit knowledge developed in universities and thus an important factor behind economic and employment growth. Second, technology transfer can generate income for universities

in the form of royalties and it can attract research funding from external sources such as private industry.

Especially concerning codified knowledge in the form of patents<sup>6</sup>, the system of intellectual property rights (IPR) is of paramount importance. It determines in universities who owns the resource “academic knowledge” and influences the incentives to exploit research results. In some countries the inventions resulting from publicly-funded research are owned by the university scholars. This so-called “university teachers’ privilege”<sup>7</sup> is frequently justified with the idealists’ principles of freedom of research and the desire for the independence of research from commercial interests. This idea is based on German idealist philosophy and in particular Wilhelm von Humboldt (Keck 1993).

In Germany, legislative action was taken in 2002 with a university reform. The university teachers’ privilege (“*Hochschullehrerprivileg*”) was abolished<sup>8</sup> accompanied by support for the establishment of a network of patent and exploitation agencies (PVAs).<sup>9</sup> These measures are part of the exploitation offensive of the German Government that aims “to put scientific research results faster on the market” (BMBF 2001, p. 2).

In Sweden, the university teachers’ privilege (“*Läraryrket*”) still exists. Since 1997, the universities have the “third mission” on their agenda. It means that university teachers, according to the law, have to fulfil three tasks: teaching, research and interaction with society in general.<sup>10</sup> Technology transfer falls usually under the heading of the third mission – even if the third mission is much broader than that.

The public debate focuses a lot on IPRs in research results. The OECD (2002, p. 52) poses the question, “Is granting ownership to the researcher a good formula? In theory, it should increase researchers’ interest in commercialisation. However, putting all the responsibility for disclosing and protecting ownership on a single individual reduces the likelihood of patenting and subsequent licensing”. Unfortunately, the OECD does not provide empirical verification of this statement. The European Commission views IPRs somewhat differently: “legislative issues (i.e. laws and legal regulations affecting ISR (industry-science relations)) are perceived by most national experts as having only small effects on the performance of ISR, in a positive or negative sense” (European Commis-

sion 2001, p. 336). Unfortunately, there is not much empirical evidence that supports the different viewpoints.<sup>11</sup> This paper contributes with an empirical analysis of the effects of patent regulation in Sweden and Germany on the incentives to patent research results from university research.

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<sup>2</sup> Note that the OECD by “institutions” here means organisations or players and not the rules of the game.

<sup>3</sup> According to Geuna (2001), the rationale for university funding after World War II rested on the assumption that the transfer of knowledge from basic research to commercialisation was seen as a linear process. According to this view, basic research (mainly carried out at the university) leads to applied research and development and then to commercialisation. The second major rationale behind public funding of academic research was the public good character of knowledge. The constraint on the national budgets as a result of the economic crisis in the 1970s led to increasing pressures on university funding. Geuna talks of the “contractual-oriented approach” that replaced the former justification for public funding of university research. Two main features of this approach are that “the university is required to support aims that are intended to enhance national economic development and the strengthening of competitiveness. Second, to obtain this result and to increase the short-term efficiency of the institution, the government makes increasing use of competitive mechanisms for resource allocation” (Geuna 2001, p. 617).

<sup>4</sup> An alternative perspective on the innovation process stems from evolutionary economics. Nelson & Winter (1982) highlight the role of random variety creation (mutation) and selection processes. In the sense of Schumpeter (1934), the economic process is characterized as a process of “creative destruction”. New products, new processes and new organisation forms introduce novelty into the economic system. These innovations destroy older patterns of economic activity. A primary element in innovation research is therefore random introduction of novelty. One particular advantage of the university system could be that university researchers search for new knowledge without preconditions. The traditional idealists perception was that researchers should not care about which kind of commercial product could occur from their research. Thus, a general problem could arise if universities adapt too much to the needs of private industry. The whole innovation system could loose its ability to introduce real novelty into the system.

<sup>5</sup> In general, technology transfer should not be regarded as a one-way process from university to industry. Technology transfer in practice means the interaction between researchers and private enterprises where both parties could benefit from each other. This is confirmed by empirical research (e.g., Meyer-Krahmer & Schmoch 1998).

<sup>6</sup> There are a number of different mechanisms of interaction with industry. Czarnitzki et al (2000, p. 17) in a survey directed towards university researchers, come to the result that university researchers in Germany regard scientific publications as the most important channel of knowledge and technology transfer to private industry. Klofsten and Jones-Evans (2000) mention eight specific types of “academic entrepreneurship” including, for instance, contract research, consulting, external teaching, spin-offs, or patenting/licensing. Thus, interaction with industry is a quite broad field. But since this paper focuses on patent right regimes in universities, the analysis is limited to patents as means to transfer knowledge and technology.

<sup>7</sup> It is called privilege because the employer usually owns inventions originating in privately owned enterprises, and not the employee (the inventor).

<sup>8</sup> § 42,43 Arbeitnehmererfindungsgesetz, ArbNErfG)

<sup>9</sup> In Germany and other countries, e.g., Australia, Austria, Belgium, Denmark, France, Ireland, Netherlands, Norway, UK, and USA the university owns the research results. The researchers own the inventions in Sweden and other countries, e.g., Finland, Italy (OECD 2003b).

<sup>10</sup> § 2 Högskolelagen (University laws). ”Högskolorna skall också samverka med det omgivande samhället och informera om sin verksamhet. Lag (1996:1392)”.

<sup>11</sup> The UTP was abolished in Denmark in 1999. There are no studies of the effects yet but it seems that the abolishment led to increased bureaucratization. Most respondents in Sweden referred to the Danish case as a kind of bad example. Italy introduced the UTP in universities in 2001. This shows that there is no clear-cut answer which system – with or without UTP – is better.

## 2 Purpose

The purpose of this paper is to assess the impact of patent regulation in universities in Germany and Sweden on the incentives to patent research results.

Two research questions will be addressed:

1. **What are the incentive effects of patent regimes in the university?** In case of Germany this means in particular: Does the abolishment of the university teachers' privilege decrease or increase incentives to invent and patent? In the case of Sweden this means: Does the university teachers' privilege give positive or negative incentives to individual researchers to invent and patent?
2. **What is the role of technology transfer offices?** Particularly important in Germany is whether the technology transfer offices<sup>12</sup> are able to patent and commercialise university research in a successful way as compared to researchers in a patent regime with university teachers' privilege. In Sweden, the objective is to elaborate on the role of technology transfer offices in a regime with university teachers' privilege.

In sum, this paper presents a comparative analysis of patent rights regimes in universities in Germany and Sweden. This covers a descriptive qualitative analysis of technology transfer processes, a qualitative analysis of the effects of patent rights regimes in universities on technology transfer, and an identification of factors that are important for technology transfer.<sup>13</sup> Furthermore, the analysis leads to policy implications that recommend how to improve the process of technology transfer.

It has to be mentioned that there are a number of different ways to transfer knowledge and results from university research. As Czarnitzki et al. (2000, p. 18) have shown, there are different mechanisms and means for knowledge and technology transfer, such as, publications, collaborative research, educating students, spin-offs. This paper assesses the impact of patent regulation on the incentives to patent research results and, as such, it focuses in particular on patents.<sup>14</sup> It focuses thus on a rather small share of university research. Most of the research results can be published in scientific journals but the extent to which research results

can be patented varies. Only tangible products can be patented which limits the analysis to university departments in which patenting is an option such as engineering or biotechnology. Furthermore, the patenting procedure is quite time-consuming which decreases the importance of patents in industries with short product life-cycles.

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<sup>12</sup> Please note that the term technology transfer office (TTO) is used in a broader meaning in this paper. It means units inside universities that support patenting and commercialisation of research results, such as industrial liaison offices, as well as intermediary organisations that support patenting and commercialisation efforts, such as independent patent and exploitation agencies and technology bridging foundations.

<sup>13</sup> Please note that technology transfer in this paper is defined in a narrow sense as patenting of research results.

<sup>14</sup> A patent is a bundle of intellectual property rights (IPRs), which is granted for a period of up to 20 years for an invention. The invention has to be new, industrially applicable and must involve an inventive step yielding sufficient advancement. According to the European Patent Office (EPO, 1999), in 1999 the costs of an average European patent amounted to 29,800 €. This includes 10 years of protection in 8 member states. About 39% of these costs are related to translations. A national patent application is cheaper. In Germany, patent protection for the first 10 years costs about 1,950 € plus costs for legal advice which can amount to 4,000 € (BMBF Patent Server 2003). The costs for a national patent in Sweden are similar.

### 3 Method

Basically, two broader questions are used to assess the impact of patent regulation in universities on the incentives to patent research results: First, what are the incentive effects of patent regimes in the university? Thus, we want to assess the incentives and attitudes towards patenting and commercialisation and, in particular, the impact that patent rights regimes have on those incentives. Second, what is the role of technology transfer offices? Thus, we want to explore the role of technology transfer offices and the infrastructure with respect to patenting of research results from universities. According to Yin (1994), a case study approach is appropriate for such an exploratory research endeavour.

Both broader questions elaborate on patenting issues in two different countries with two different patent rights regimes. As such, a comparative analysis is required to find out more about the impact of the IPR regimes in question. The first research question will be addressed on the level of individual researchers. The second research question is investigated on the level of organisations, i.e. universities and their technology transfer offices, and intermediary organisations. Furthermore, broader structural factors, such as the national science systems will be considered.

From a methodological point of view it is important to find out more about the different factors that are important for patenting of research results. Theoretical analysis incorporating different theoretical arguments as well as recent empirical evidence is used to develop a model that covers those important factors. This model is used in the comparative study to guide the empirical work. A qualitative case study method was chosen since this approach fits the exploratory purpose of this study quite well and it “allows an investigation to retain the holistic and meaningful characteristics of real-life events” (Yin 1994, p. 3). In addition, the establishment of transfer infrastructure is quite recent in Germany and quantitative data is lacking to a considerable extent. Furthermore, quantitative analyses require a larger sample. Sweden has only a small number of universities, thus, quantitative generalisations have limited value. Another reason for a qualitative study is the lack of patent data. Patent data is published earliest 18 months after the application was

submitted to the patent office. The university teachers' privilege was abolished in Germany in 2002. That means that the first patent data after the abolishment is available in the beginning of 2004.<sup>15</sup> A qualitative study using interviews was therefore conducted. From a theoretical perspective, this paper applies new institutional economics. The general aim of this theoretical approach is to assess the impact of institutions on individual incentives and behaviour. The empirical comparison of discrete governance structures, e.g., IPR regimes, is dominated by a case study approach as mentioned by Brousseau and Glachant (2002).

According to Siegel et al (1999) an interview-based study involves four methodological issues. First, issues concerning the sample selection have to be taken into account. Second, an important role plays the nature of the interview questions. Third, the researcher has to elaborate on the procedure for conducting the interviews. Fourth, the qualitative data analysis has to be addressed. I will elaborate on them in turn.

First, the researcher has to select a sample. I interviewed stakeholders from universities and independent intermediaries. At universities, interviews with representatives from the university's technology transfer office (TTO) or university holding company and alike were conducted. Representatives from independent intermediaries – in Germany PVAs (*Patent- und Verwertungsagentur PVA*) and in Sweden TBS (*Teknikbrostiftelser TBS*) – were interviewed. In addition interviews with researchers were conducted to get an idea about how they perceive infrastructure and the process of technology transfer.<sup>16</sup> I conducted interviews with stakeholders at four universities in Germany and four universities in Sweden. To ensure comparability, technical universities and universities with strong technical faculties were chosen since patenting and commercialisation issues are most important and relevant in the technical disciplines and pharmaceuticals.<sup>17</sup> The German universities are located in four different federal states and every federal state has its own PVA. In Sweden, every university region has its own TBS. Table 3 and 6 in the appendix show the characteristics of the chosen universities. In this study, I wanted to draw a sample of respondents that reflect representative attitudes of these stakeholder groups. To achieve that, I interviewed the CEOs or directors of the different organisational units. In total, I conducted 23 interviews. A list of respondents with affiliations can be found in the reference list.



Second, the theoretical framework was used to design an interview guide. At least two semi-structured interviews per case were conducted - one interview with a responsible person in the university (university holding and alike in Sweden, technology transfer office and alike in Germany) and one interview with a responsible person (in most cases the CEO) in an intermediary organisation (technology bridging foundation in Sweden, patent and exploitation agency in Germany). Additional data was collected through internet research and other sources. Interviewees were asked the same questions, although some questions were tailored to a particular group. The interviews were conducted in Swedish and German to avoid interpretation errors.<sup>18</sup> According to Siegel et al (1999), the best approach for an exploratory study is to ask open-ended questions, such as “what is the role of your organisation” or “how could the situation be improved”. During the interviews, a “steering” or channelling of the answers was avoided. The interviews were mainly exploratory.

Third, the interviews were conducted in two ways. Most of the interviews were face-to-face interviews. In the literature it is claimed that this type of interview is the best way when conducting an inductive study on a controversial topic. Face-to-face interviews have a number of advantages.<sup>19</sup> It is possible to ask a number of complicated questions and it is possible to reduce obscurities through additional information. It is easier for the respondent to answer open questions and the trustworthiness of the answers increases due to a development of a personal relation during the interview. But a number of disadvantages have to be taken into consideration. Face-to-face interviews are rather expensive and time-consuming which limits the number of interviews that can be conducted in such a way. In addition, interviewer effects can occur since the personal relation can impact on the answers. There is a risk that the interviewees answer the questions in that way that they think the researcher expects or “likes” it.

The second type of data collection was telephone interviews to get complementary data. As with face-to-face interviews, a number of advantages favour telephone interviews. It is a quite fast and cheap way of data collection particularly in comparison with face-to-face interviews. Obscurities related to the questions can be sorted out. But telephone interviews have a number of shortcomings. It can be quite difficult to ar-

range a telephone interview. It is very difficult to establish a personal relation between researcher and respondent. This can lead to refusals to take part in the study on the side of the interviewees.<sup>20</sup> The time for telephone interviews is usually limited and it is difficult to ask complicated and sensitive questions. The environment can disturb the interview, in particular when respondents answer other phone calls. There is a risk for less thought-out answers. Therefore, telephone interviews were primarily used to increase the amount of qualitative data and for verification of the results from the face-to-face interviews.

Fourth, there are three stages of qualitative analysis according to Miles & Huberman (1994): data reduction, data display, and conclusion drawing/verification. The different stages are intertwined and can be characterized as a continuous, iterative process. According to Miles & Huberman (1994, p. 10), “*data reduction* refers to the process of selecting, focussing, simplifying, abstracting, and transforming the data that appear in written-up field notes or transcriptions”. It is a part of the analysis and depends pretty much on the researcher’s judgement which data to include in the transcript and which data to exclude. Data reduction sharpens, sorts, focuses, discards and organizes data in such a way that conclusions can be drawn. In this study, most of the interviews were taped and transcribed roughly focusing on the essence of the interviews’ content.<sup>21</sup>

The second stage in the analysis is *data display*. “Generically, a display is an organized, compressed assembly of information that permits conclusions drawing and action” (Miles & Huberman 1994, p. 11). The first type of data display in this study is the transcriptions of the interviews. This provides a first display of the (reduced) interview data. To summarize the data from the interviews and to display the data in a more comprehensive and accessible way, figures illustrating the relations between the different actors were developed. The interviewees’ responses about the process of patenting and commercialisation were transformed into stylized models. Furthermore, quantitative data obtained from the respondents was arranged in overview tables.<sup>22</sup> As mentioned by Miles and Huberman, data display is an integral part of the analysis. It eases the drawing of conclusions.

The third stage is *conclusion drawing and verification*. Miles & Huberman (ibid., p. 11) claim that “from the start of data collection, the qualitative analyst is beginning to decide what things mean – is noting regularities, patterns, explanations, possible configurations, causal flows, and propositions.” Prior to the data collection, a theoretical model was developed.<sup>23</sup> This theoretical model was used to develop hypotheses and those hypotheses were used to develop the interview guide. During the interviews, specific follow-up questions were posed tailored to the specific circumstances of the cases. In the process of conclusion drawing and verification, conclusions are also verified as the analysis proceeds. The analysis of the transcriptions revealed a number of common issues that emerged in most of the interviews. Those common issues are presented in the descriptive part of this paper (5.4).

It has to be mentioned that this study is not a detailed study of patenting at eight universities. It is a comparative study of the effect of two different patent rights regimes in two countries. The eight cases are only used to illustrate the process of patenting and commercialisation in two countries. Therefore, this paper presents the most important results in the two countries and not particularities of eight universities.

The remaining part of the paper is structured in the following way. In chapter 4, the theoretical framework is briefly presented. Chapter 5 presents the cases. It describes the Swedish and German IPR regimes, provides an overview of the Swedish and the German systems of scientific research, and a description of the infrastructure for commercialisation in both countries. Chapter 5 provides a descriptive qualitative analysis of technology transfer processes in both countries. Chapter 6 compares the German and the Swedish cases. This chapter provides a qualitative analysis of the effects of patent rights regimes in both countries on the incentives to patent research results. Furthermore, another outcome of this comparative framework is the identification of factors that are important for technology transfer in both countries. Chapter 7 concludes and gives some policy implications.

<sup>15</sup> Furthermore, according to Gering & Schmoch (2003, p. 80), “from a methodological point of view it is not possible to provide reliable statistics on university patents and licences in Germany. Until the abolishment of the university teachers’ privilege the professors privately owned their inventions”. Nevertheless, “it is possible to provide quite reliable statistics on inventions made by professors because in Germany the title “professor” is exclusively used for university professors, and they generally use it in official documents.” (ibid, p. 80). Patent databases can therefore be searched for the title „professor“ in the inventor category. Unfortunately, Swedish professors are not so keen on using their title as their German counterparts as a tentative search in patent databases confirmed.

<sup>16</sup> This paper is part of an ongoing PhD project. The next step is a web-based survey of researchers in Sweden and Germany. This will lead to a quantitative analysis of the impact of patent regimes.

<sup>17</sup> The subjects chosen to identify the universities were civil engineering, electrical engineering and mechanical engineering. Nevertheless, the results are valid for other technical subjects as well since the TTOs, Holding companies, TBS and PVAs have a broad focus servicing all subjects. In Germany, university rankings of the Centre for university development were used to identify the German universities (Berghoff et al 2002 & 2003). The RWTH Aachen was chosen since it is in the group of top universities in Germany in basically all of these subjects. The technical university of Hamburg-Harburg (TUHH) was chosen because it is the youngest of all technical universities in Germany founded in 1978 and it was the first German university that transformed its technology transfer office into a limited corporation. This served as a model even for other universities. The university of Karlsruhe is the oldest technical university in Germany and it has a strong reputation in engineering. The technical university of Berlin (TUB) has a strong record in electrical engineering. In Sweden, the two strongest technical universities, Royal Institute of Technology (KTH) in Stockholm and Chalmers University of Technology in Gothenburg, were chosen. In addition, Linköping University was chosen because it is a quite young university and the author had easy access to data. Lund University was chosen since it has a quite long history of university-industry collaboration. Particularly important is Ideon, the first science park in Sweden. Ideon was founded in 1983.

<sup>18</sup> The author is fluent in German and Swedish.

<sup>19</sup> For the advantages and disadvantages of different types of data collection techniques, see Dahmström (2000).

<sup>20</sup> In some instances, I was not able to conduct telephone interviews with people I wanted to include in the sample. Reasons were interviewees’ lack of time or they simply refused to take part in the study.

<sup>21</sup> Some respondents did not like the interview to be recorded. I respected those wishes.

<sup>22</sup> Please note that the tables provide an overview only. In some cases, the data quality can be questioned. As already mentioned, the next step in this PhD project is a quantitative analysis.

<sup>23</sup> This theoretical model can be found in Sellenthin (2004a, forthcoming) and in chapter 4.

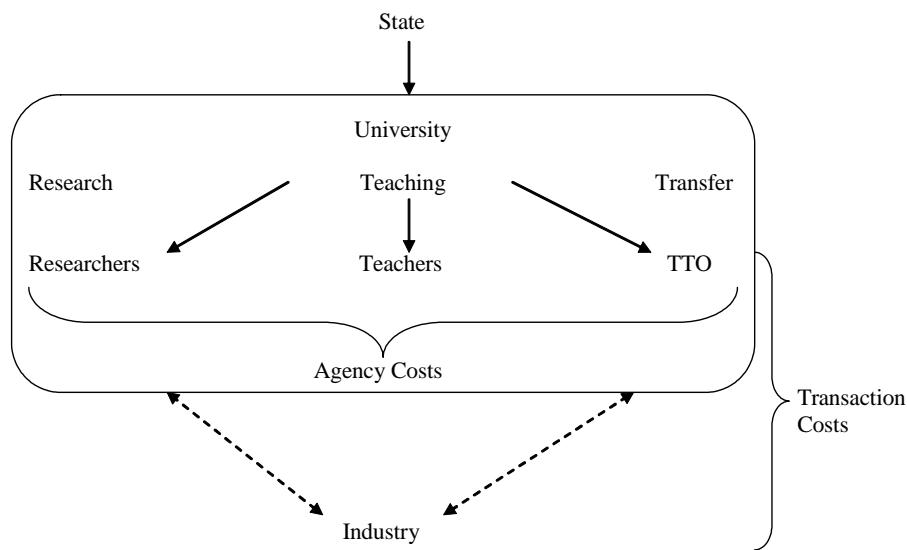
## 4 Theoretical framework

The purpose of this paper is to assess the impact of patent regulation in universities in Germany and Sweden on the incentives to patent research results. New institutional economics is applied since it explicitly analyses the effects of institutions. The system of intellectual property rights in universities represents such an important institution.<sup>24</sup>

From the perspective of neo-classical economics, ownership does not matter. “When transaction costs are zero, an efficient use of resources results from private bargaining, regardless of the legal assignment of property rights” (Cooter & Ulen 1996, p. 82). This is the famous Coase theorem.<sup>25</sup> The theorem states basically two things. First, private bargaining will always result in an efficient use of resources. Second, it means in a frictionless world without transaction costs, it simply does not matter whether the university or the researcher owns the property rights in the research result. The resource (the IPR in research results) will always move to that party who values it the most. But in reality, different types of transaction costs exist. Therefore, “when transaction costs are high enough to prevent bargaining, the efficient use of resources will depend upon how property rights are assigned” (ibid, p. 82).

In reality, there are transaction costs that possibly hinder the property rights in research results to move from university or researcher to the party who values it the most, probably private industry. We have to distinguish between two types of costs. First, the coordination of the different tasks inside the university and the problem to accommodate the different interests of the university and its researchers causes costs. Those costs of internal organisation inside hierarchies are in the literature referred to as “agency costs”.<sup>26</sup> Furthermore, the transfer of property rights in research results from the university or the researcher to private industry – through, e.g., licensing or start-up – is costly as well. Those costs caused by using the market mechanism are frequently called “transaction costs”. The analysis of patenting and commercialisation of research results has to take into account both types of costs. This chapter provides the general theoretical argumentation applied in this paper. Figure 1 provides an illustrative overview.

Figure 1 Transaction costs and agency costs in universities



#### 4.1 Agency costs

Universities have different goals. The university laws in Sweden and Germany demand three objectives that universities should accomplish. Universities should conduct research, educate students and interact with the surrounding society. The third mission – interaction with the surrounding society – can take different forms. It includes popular lectures, publication of popular books, public advisory services and technology transfer, just to name a few. Technology transfer – a transfer of knowledge from university to industry – has gained increasing attention in the last years.<sup>27</sup> But the discussion frequently neglects the much broader mission of universities.<sup>28</sup> From an economic point of view, patenting and commercialisation of university research and technology transfer can be viewed in the context of multiple principal-agent theory.<sup>29</sup> It deals with the general problem of accommodating between different goals inside hierarchies and to provide incentives to the employees – in our case the researchers – to accomplish all tasks.<sup>30</sup>

The typical result of multiple principal-agent theory is that the pay-offs<sup>31</sup> (wages) for all activities have to be equal to provide incentives to the agent to accomplish them all.<sup>32</sup> If the relative pay-off or reward is higher for one of the activities, there will be an incentive that the agent fulfils only this activity. For instance, the primary merit in universities is publication in renowned journals, which provides strong incentives to focus on research only. When we now concentrate on researchers we see that they should actually accomplish all three tasks simultaneously. It becomes obvious that the different goals can be in conflict with each other and trade-offs in the daily routines of scholars which goal to prioritise can arise.

## 4.2 Transaction costs

Transaction costs economics examines the “comparative costs of planning, adapting, and monitoring task completion under alternative governance structures” (Williamson 1985, p. 2). With respect to the market mechanism, these costs are usually called search costs, contract costs, and the costs of contract enforcement. In general, Williamson (1985) distinguishes between market and human factors that impact on transaction costs. The market factors include uncertainty, frequency, and asset specificity.<sup>33</sup> Human factors consist of bounded rationality and opportunism.

In general, uncertainty and asset specificity are important market factors that increase transaction costs in the context of patenting and commercialisation of research results from universities. Most of the empirical studies show that the distribution of license income from university research is very skewed.<sup>34</sup> This means, the outcomes of commercialisation efforts are highly uncertain which results in a low expected value of this activity. One important result of transaction cost economics is that high transaction costs make market coordination unlikely. This is particularly important with respect to asset specificity. Patenting and commercialisation requires high specific investments, e.g., the establishment of TTOs and other supportive actors. Those investments are sunk in case of failure.<sup>35</sup> This could explain why most of the supportive actors are publicly financed (PVAs & TBS). The market does not provide those services.

Transaction costs can be fairly high with respect to the third mission. This has an impact on the reward for transfer efforts. But transaction costs can be lowered by supportive infrastructure. Whether supporting agents (e.g., TTOs, PVAs, TBS) have incentives to engage in technology transfer depends heavily on property rights.

### 4.3 Property rights

It is obvious that there are transaction costs with respect to patenting and commercialisation of university research. Thus, the allocation of property rights matters for economic efficiency. Property rights in research results can be regarded to be of crucial importance for the incentives to patent and commercialise university research.<sup>36</sup> According to Will & Kirstein (2002) the abolishment of the university teachers' privilege in Germany implies two types of incentive effects. First, it can give incentives to the researcher to invest in inventive effort. Second, it can give incentives to the university to engage in utilisation efforts. Unfortunately, Will and Kirstein do not provide empirical estimates about the strength and direction of the incentive effects.

In general, it is likely that the different ownership regimes in Germany and Sweden lead to different utilisation and exploitation efforts of the university.

According to Faure and Skogh (2003, p. 62), property rights can be characterized as a bundle of rights that include:

- right to disposal and use
- residual right
- right to compensation
- freedom of contract.

The use and disposal right means that the owner of a resource can freely dispose over it as long as the use is not prohibited by other laws. The residual right includes the right to profit and the duty to cover losses. As mentioned by Faure and Skogh (*ibid*, p. 62), "the owner is, thereby, a risk-taker. The risk, and the chance of profit, gives the owner an incentive to maximize the utility or profit of the property." Furthermore, "a transfer of ownership requires that the right to the residual value of the property be transferred. Hence the residual right is the essence of ownership". The right to compensation safeguards that the owner of property



can assert his rights upon infringement. This can be the case when the property is damaged. “With ownership comes not only the possibility of excluding others and enjoying the profit but also the obligation of bearing the costs that are attached to the property, including compensation to other owners who have been harmed” (ibid., p. 63). Freedom of contract means the right to transfer rights by contract and gift. Freedom of contract is a crucial precondition for a market economy since it enables voluntary agreements about transfers of property rights. Trade based on voluntary agreements is assumed to be mutually beneficial. But this is only true if all parties affected by trade are included and accept the terms. This means if externalities are absent. In sum, property rights represent a whole bundle of rights. It is, therefore, not easy to identify rights clearly. The right to dispose and use is usually limited by regulations.<sup>37</sup> Thus, in-depth case studies have to show which bundle of property rights is actually in place.<sup>38</sup>

The residual right is the core of ownership. Furthermore, freedom of contract results in voluntary agreements that are beneficial to all parties involved. It safeguards that the owner of a resource receives all utility and profit associated with the property but in return she has to bear all costs. An efficient property rights regime internalizes all costs and benefits attached to the property. In that case, the owner as decision-maker conducts the trade-off between costs and benefits.<sup>39</sup> But in reality, not all costs and benefits associated with property are internalized. External effects may distort the efficient pricing of resources. We can distinguish between positive and negative external effects. Positive external effects mean that benefits are not included in the pricing of the resource. Knowledge spill-overs are typically characterized as positive externality. The result is that the owner of the resource does not include those benefits in her cost-benefit analysis, which results in underinvestment in productive activities. The patent law is one way to internalize those positive externalities. The second case is negative externalities or negative external effects. This means that some costs are not included in the pricing of the property. Environmental problems such as pollution are typical examples of negative externalities. Since those external costs are not included in the calculations of the property owner the decision-making process of the property owner is disturbed. This can result in an ineffi-

ciently high activity level related to the property right, e.g., industrial production that causes pollution.

In our context of patenting and commercialisation of university research, the allocation of property rights in research results plays an important role. In both countries, the researchers dispose and use resources that are financed by other parties – e.g., the state, external private and public financiers. But the extent to which the researchers receive the benefits varies. Furthermore, university research involves externalities, e.g., positive externalities in the form of knowledge spillovers associated with free dissemination of results. One way to internalize those externalities is patenting.

In sum, this theoretical chapter discussed agency costs, transaction costs, and property rights. The theoretical result of multiple principal-agent theory is that the rewards for each of the tasks have to be equal to give incentives to researchers to accomplish all goals or missions of the university. The agency costs have to be seen in relation to the transaction costs. Transaction costs of patenting and commercialisation efforts can be regarded quite high. Finally, it was shown that the allocation of property rights matters for decision-making and as a result economic efficiency.

<sup>24</sup> The term institution in this study refers to “the rules of the game” in accordance with North (1990). According to Cooter & Ulen (1996, p. 3), “economics provides a scientific theory to predict the effects of legal sanctions on behavior. To economists, sanctions look like prices, and presumably, people respond to these sanctions much as they respond to prices”.

<sup>25</sup> The Coase theorem goes back to the seminal article by Coase (1960). It is used as a reference point to illustrate the importance of transactions costs and property rights.

<sup>26</sup> Agency costs consist of control costs of the principal, bonding costs of the agent, and the residual loss (e.g., Erlei et al. 1999, p. 75).

<sup>27</sup> A number of investigations are focusing on this topic, e.g., Cohausz et al (1998), Czarnitzki et al. (2000), SOU 1996:70, VINNOVA (2003), RRV (2001), European Commission (2001), OECD (1999, 2002, 2003a, 2003b).

<sup>28</sup> The dominating view on commercialisation of university research is that researchers should act like entrepreneurs. Henrekson and Rosenberg (2000, p. 11) claim that the main reason why commercialisation is more successful in USA compared to Sweden is that entrepreneurial culture is more developed in the US. One of their suggestions to increase commercial activity of universities is to change the content of academic courses and the allocation of funding for conducting research towards the demands of private industry.

<sup>29</sup> Holmstrom & Milgrom (1991, 1994) developed the multiple principal-agent theory.

<sup>30</sup> The principal – in our case the university - delegates tasks to an agent – in our case the researcher. Problems arise in such a situation if the principal cannot observe the behaviour and performance of the agent. This measurement problem is the result of asymmetric information between principal and agent and the costs of control. Both factors mean that the agent can exploit the information asymmetries resulting in behaviour that is not fully in accordance with the principal’s objectives.

<sup>31</sup> Please note that we talk about relative pay-offs in this context. Researchers receive usually a fixed wage. But the opportunity costs associated with the three different tasks are likely to be different which can result in different relative wage rates for each of the activities. E.g., researchers who never interacted with industry will have high costs in terms of time and effort needed to accomplish the third mission. In contrast, researchers are used to publish papers, which results in low costs in terms of time and effort. The individual costs associated with the different activities depend pretty much on individual factors, such as experience. The individual productivity of the different tasks has an impact on those individual costs.

<sup>32</sup> The academic reward system plays an important role in this context. An elaboration about incentive structure in universities can be found in the appendix.

<sup>33</sup> The problem of asset specificity arises in an inter-temporal context. According to Williamson (1985, p. 54), “parties to a transaction commonly have a choice between special purpose and general purpose investments. Assuming that contracts go to completion as intended, the former will often permit cost savings to be realized. But such investments are also risky, in that specialized assets cannot be redeployed without sacrifice of productive value if contracts should be interrupted or prematurely

terminated”. Williamson (ibid, p. 95) distinguishes between four types of asset specificity. “Site specificity – e.g., successive stations that are located in a cheek-by-jowl relation to each other so as to economize on inventory and transportation expenses; physical asset specificity – e.g., specialized dies that are required to produce a component; human asset specificity that arises in a learning-by-doing fashion; and dedicated assets, which represent a discrete investment in generalized (as contrasted with special purpose) production capacity that would not be made but for the prospect of selling a significant amount of product to a specific customer”. In our case, TTOs can be interpreted as discrete investments that would not be made without the possibility to exploit a large number of university inventions.

<sup>34</sup> For example, VINNOVA (2003, p. 14) shows that at Stanford University about 15% of the research based projects in which resources were invested for patenting and commercialisation (via licenses or start-ups) “produced” benefits that covered the costs. Less than 0.5% resulted in returns larger than 50 million SEK. But one single project generated about 5% of Stanford’s research budget in about 10 years. This means that a limited number of university patents generate the majority of license income.

<sup>35</sup> Furthermore, investments in start-ups are highly specific. They cannot be moved to another transaction and are sunk in case of failure. Thus, transaction costs of this type of transfer are expected to be fairly high. Securities, such as ownership transfer or board membership in the start-up enterprise are frequently used to secure these specific investments (Gebhardt & Schmidt 2002).

<sup>36</sup> There is a rich body of literature about patent law in general (see e.g., Kitch (1998) for an overview). Most of the literature focuses on problems of the optimal length and breadth of patent rights. Those questions are left out of consideration in this paper.

<sup>37</sup> For instance the owner of a piece of land is usually restricted in the use of the land. It is usually forbidden to engage in dangerous activities, e.g., building a nuclear power plant, on your own land.

<sup>38</sup> An illustrative case of property rights in endangered species is presented in Sellenthin & Skogh (2004, forthcoming)

<sup>39</sup> In a formal way this means that the owner will maximize the value of the property and the outcome will be that marginal costs equal marginal benefits. See Schmidtchen (1998) for an elaboration of the conditions for efficient property rights.

## 5 The Cases: Sweden and Germany

This chapter presents the German and Swedish cases. It starts with an overview of the science systems in both countries to situate the cases in a broader context (5.1).<sup>40</sup> It proceeds with explaining the main properties of the property rights regimes regarding university inventions in both countries (5.2). In 5.3, the infrastructure for patenting and commercialisation is presented. At the end of the infrastructure description, a descriptive qualitative analysis of technology transfer processes in the form of stylised models is provided. Two figures illustrate the technology transfer processes in Sweden and Germany. Finally, important issues from the interviews are presented (5.4).<sup>41</sup>

### 5.1 Structural factors: the science system

Closely related to IPRs in universities is the organisation and funding of research since these also act as important constraints in the academic sphere. The system of academic research in Sweden consists mainly of universities and colleges (*högskolor*). Most of the research is conducted at public universities.<sup>42</sup> Research institutes that are not linked to universities are of minor importance.<sup>43</sup> Recently, a number of national competence centres connected to universities were built up. These centres are financed by industry, the university, the Swedish Agency for Innovation Systems (VINNOVA) and the Swedish Energy Agency.<sup>44</sup> In these competence centres, university researchers and researchers from the financing enterprises conduct collaborative research. The IPRs for the research results are transferred to the collaborating firms. The university teachers' privilege is not valid in these cases. This means that researchers that collaborate in these national competence centres do not own the research results.<sup>45</sup>

Governmental funding to universities is allocated via direct (base) funding of universities (*fakultetsanslag*). In addition, there is the possibility to receive external funding via a number of research foundations (*forskningsstiftelser*), research councils (*forskningsråd*), governmental departments, the EU, private enterprises, etc. The funding of academic research has changed considerably. The importance of external funding increased from 42.6% of the total budget in 1993/94 to 53.1% in 2000

(Hällsten & Sandström 2002). In 2002, external funding accounted for about 55% of total research funding (HSV 2003). There are universities that receive over 60% of total funding from external sources.<sup>46</sup> In sum, research in Sweden is mainly conducted at public universities and the universities are increasingly dependent on external funding.

In contrast, Germany has a diverse research landscape. Publicly financed research is conducted in universities, technical universities, colleges (*Fachhochschulen*), and specialised research institutes (e.g., Fraunhofer institutes, Max Planck institutes).<sup>47</sup>

The study by Czarnitzki et al (2000) investigated the interaction between science and industry in Germany. They analysed seven types of research institutes in Germany with respect to the preconditions that are needed for technology transfer and the extent to which transfer really took place. Only the results for the universities are presented here.<sup>48</sup> The reader has to have in mind that only about 52% of public R&D in Germany is spent at universities as compared to 82% in Sweden. The table 1 below shows a number of figures for universities in Germany and Sweden.

Table 1 Some structural data about German and Swedish universities. The German data is modified from Czarnitzki et al (2000), the Swedish data Hällsten & Sandström (2002). All figures refer to 2000.

	Universities/Technical Universities Germany	Universities Sweden
Research in natural sciences & engineering	38.8%	n.a.
Basic research orientation	57% / 38%	n.a.
Base funding	65%	46.9%
Industry funding (share of total budget)	7% / 11%	6.3%
Share of public R&D spent in universities	44.9% / 7.1%	82%

It seems that universities fulfil different functions in Sweden and Germany. The major share of public research in Sweden is conducted at universities. In Germany, specialised research institutes, such as Max-Planck institutes or Fraunhofer institutes, play an important role. About half of public R&D is spent in universities. This is probably reflected in the numbers for base funding as well. In Germany, about 65% of the total budget of universities is funded through base funding whereas this is only true for about 47% in Sweden. The share of industry funding seems to be quite similar.

## 5.2 Property rights regimes

The university teachers' privilege in **Sweden** (§ 1,2 *Lagen om rätten till arbetstagares uppfinningar 1949*) gives the university teachers the intellectual property rights (IPR) for their research results. That means, the university researcher owns the right to publish the results in scientific publications, she can apply for a patent to exploit the research results commercially, but there are also a lot of other means to exploit research results. The university scholar has full discretion about the means of knowledge dissemination. The university or other parties have no right to interfere with this decision. In the case of patenting, the researcher receives the entire benefits emanating from the patent but has to bear all costs of patenting. The Swedish regulation is dispositive (default rule), i.e. the university teachers' privilege is only valid in the case of the absence of other contractual agreements.<sup>49</sup> Contractual agreements have priority over the university teachers' privilege. Universities can even abolish themselves the UTP in contractual negotiations with the scholars.

As mentioned above, a university researcher acts in an environment with a number of different, partly conflicting goals. Since the scholar has the right to decide what happens with the research results, she has a number of options. One option would be to focus on the commercialisation of research. This can be done through an own patent application possibly leading to spin-off or licensing the patent to other parties. Or the university researcher and funding organisations (e.g., private enterprises) can agree on a contract that gives the university scholar funding in return for a transfer of IPRs for subsequent inventions. Another option would include free dissemination and publication of the research results. But pat-

ent and publication do not have to be in conflict. First, the inventor or a third party (e.g., collaborating firm or agents in the infrastructure) can apply for a patent. Second, the inventor can publish the results in scientific journals.<sup>50</sup>

The university teachers' privilege was abolished in **Germany** in February 2002 (§ 42,43 *Arbeitnehmererfindungsgesetz, ArbNErfG*). Inventions made by university teachers are now owned by the university.<sup>51</sup> In case of a patentable invention, the scholar has to notify the university. The university has four months to decide whether to patent the invention or not. In case of no decision after four months, the researcher receives the IPRs. In case of a publication that would foreclose a patent application, the scholar has to notify the university and has to withhold the publication for two months. The university is not allowed to prohibit or change the content of the publication.<sup>52</sup> The compensation for the researcher in the case of a patent application and successful commercialisation is 30% of the gross income. The costs associated with patenting and commercialisation are not deducted. Patent and exploitation agencies (*Patent- und Verwertungsagenturen, PVA*) assist universities in patenting and commercialisation. Most of the PVAs are independent from the universities.

University scholars in Germany do not have as many options as their Swedish counterparts. They are not allowed to commercialise their research results on their own. Nevertheless, they receive a large share of the commercial benefit when the universities (usually represented by patent and exploitation agencies) commercialise their results. The researchers receive the IPRs only if the university is not interested in commercial exploitation.

### 5.3 Infrastructure for patenting and commercialisation

This section presents the main actors in the infrastructure for patenting and commercialisation of university research in both countries. It builds upon the interviews and secondary material. In Germany, the process of patenting and commercialisation is prescribed by law to a considerable extent. In Sweden, researchers can decide on a voluntary basis whether they want to involve supportive actors. Supportive actors include technology transfer offices at universities, technology bridging foundations, university holding company, etc. The supportive actors in Sweden have



only information about inventions that are commercialised by them. Selection effects have to be considered. It is likely that the more successful – or more attractive to researchers – actors in the infrastructure possess more information than the less attractive ones. In contrast, actors in the commercialisation infrastructure in Germany are likely to have a broader picture since researchers have an obligation to disclose inventions and to take part in the commercialisation process as prescribed by law or as the university regulates it.

### 5.3.1 Infrastructure for commercialisation in Sweden

The university laws in Sweden were changed in 1997 to include the so-called “third mission”. The third mission means that university employees have to interact with society in general. The aim is that the knowledge produced inside universities should spill over to society. This includes popular lectures and publications aimed at a general audience. But this also includes technology transfer and collaboration between universities and industry. With regard to publicly financed supporting infrastructure, RRV (2001, p. 18) mentions organisations that support universities in their third mission efforts, including technology bridging foundations (*teknikbrostiftelser*, *TBS*), university holding companies, and science parks.<sup>53</sup> These organisations are of primary interest in relation to patenting and commercialisation of university research.<sup>54</sup> Thus, three major actors can be identified that are of relevance when it comes to the supporting infrastructure for patenting and commercialisation in Sweden: The university, their university holding companies, and technology bridging foundations.

The university has, through the third mission, the obligation to create and sustain an effective process of interaction with the surrounding society. The university can fulfil this mission through different means such as popular lectures, university fairs, “open university days” and the like. A number of the respondents mentioned that the universities do not receive additional funding to achieve the third mission (Blomberg, int., 2004, Wessman, int., 2004). Universities receive funding for education and research but the third mission is usually not covered by financial resources. RRV (2001, p. 36) regards collaboration with industry the most important part of the third mission.

Five holding companies were founded in 1994 and six in 1995. They received about 7 million € from the government. Their aim is “to own, sell and administer shares of wholly or partly owned project and service companies whose purpose should be to pursue research and development aiming at commercial exploitation” (RRV 2001, p. 33, own translation). The university holding companies are owned by the universities and can be seen as the major instrument of the universities to achieve collaboration. The holding organisation separates this activity from the rest of the university. The university holding company becomes a professional organisation with a number of goals, in particular supporting universities’ third mission efforts. This includes provision of information and advice to scholars regarding patenting and commercialisation. Some holding companies are actively involved in commercialisation through the establishment of new enterprises. Since Chalmers was changed into a foundation in 1994 it did not receive money for a holding company. But they established a holding company already in 1985, Chalmers Innovation AB. Chalmers Innovation AB is a business incubator. The holding companies in Linköping and Lund provide basically information and advisory support to scholars. The holding company in Lund provides even seed capital. Financial support of commercialisation projects through the holding companies is rather limited. At KTH, the organisation of support changed recently. KTH Holding is still active but KTH Innovation collaborates with the holding company to increase commercial exploitation.

The technology bridging foundations (TBS) have a broader mandate. The seven TBS were founded in 1993. They received about 110 million € from the Swedish wage-earner funds. Their major aim is to “act for increasing contacts between university and industry in the whole country with the purpose of increasing the exploitation of universities’ knowledge and competence to increase growth in Swedish industry” (RRV 2001, p. 32, own translation). They are basically active in three areas: I) They support patenting and licensing of research results, including assessment of the commercial impact of the product and financial support (e.g., seed capital), II) they increase contacts between university and industry, including collaborative research projects, and III) they should increase collaboration between small and large enterprises in the projects in which the TBS is involved. The four TBS that were studied in more detail in this project have partly different roles.

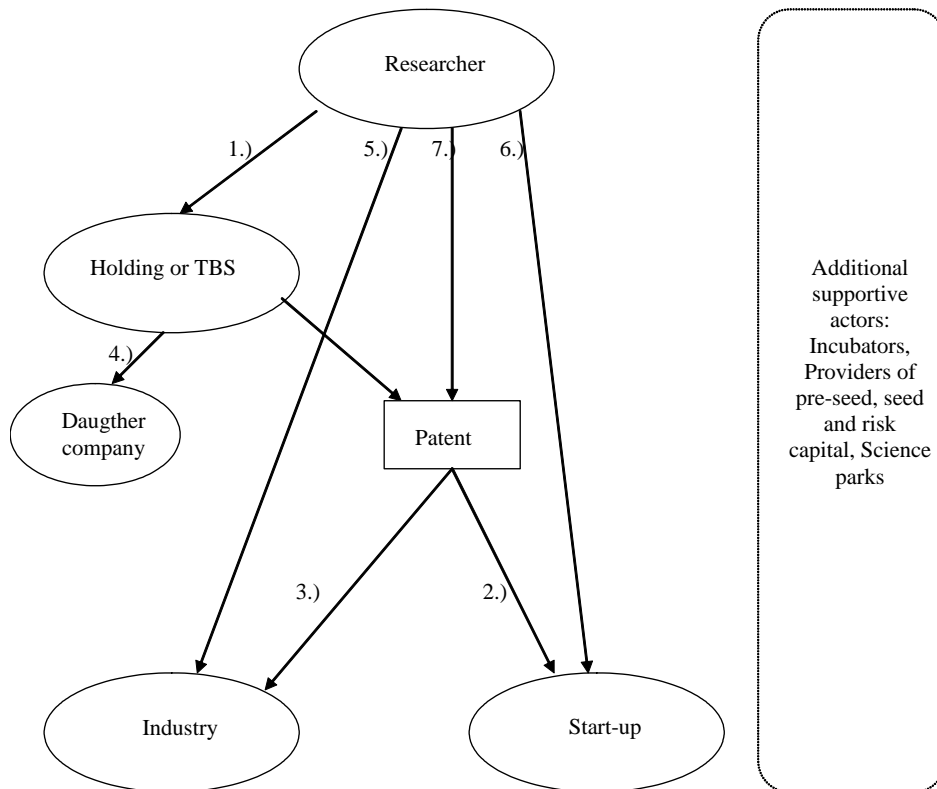
In Stockholm and Gothenburg, the TBS are not involved in operative business. Both TBS support the universities and finance infrastructure for patenting and commercialisation of university research. The TBS in Gothenburg offers scholarships for idea development of up to 100.000 SEK. Since 2002, TBS in Gothenburg provides seed capital. In contrast, the TBS in Lund is very operative. It provides a broad range of support through its different daughter companies. The TBS in Lund runs a business incubator, a patenting and licensing office, a seed fund and they run a conditional loan fund (13.5 million SEK). In Linköping, the TBS changed its organisational structure recently. TBS in Linköping is not operative anymore but runs four daughter companies that support commercialisation of research results from the university. It runs a licensing office for health care innovations, a business incubator, and a seed capital company.

*A stylised model of the process of patenting and commercialisation in Sweden*

Four Swedish universities and their supporting infrastructure were studied in more detail. The following stylised model presents the common characteristics of the process of patenting and commercialisation of research results.<sup>55</sup>

The process of patenting and commercialisation in Sweden can be characterized with figure 2 below.

Figure 2 A stylised model of the process of patenting and commercialisation of research results in Sweden



Since the researcher has full discretion about the utilisation of her research results, there is no single way of commercialisation. Carlsten (int., 2004) mentions that there are many different ways to commercialise university research. The supporting infrastructure should account for this variety. One possibility would be free dissemination through publication of the research results.

In case of commercial exploitation, the scholar can contact the university holding company or the TBS (1.). In those regions where the TBS is more operative, like in Lund, the TBS and holding company are in a more competitive relationship. In regions, where the TBS finances other actors (e.g., university holding company) only, like in Gothenburg, Linköping and Stockholm, the holding company is usually the first con-

tact point. The holding company/TBS conducts usually the first commercial assessment. This can involve advice and information and arranging contacts to other supporting actors. The next step in the commercialisation process can be a patent application if the invention is patentable. The patent application has usually to be financed by the inventor. In some regions (e.g., Gothenburg), there are financial funds available for the patent costs. Basically all respondents indicate that there is a lack of funding of the very first steps of commercialisation right now and that this is likely to act as an obstacle for scholars to patent and commercialise research results. After the patent is granted it can be used as an asset in a start-up or spin-off (2.) or can be sold or licensed to existing companies (3.). There is also the possibility that the holding company supports the entrepreneur and establishes a daughter company (project company) (4.). Those are the typical steps when the TBS/holding company are involved. Alternatively, the researcher can sell the invention directly to industry (5.) or establish a new enterprise independently (6.). The scholar can also apply for a patent independently (7.). Forskarpatent i Syd in Lund can provide the whole range of services around patenting and licensing if researchers transfer their IPRs to them. Forskarpatent covers all costs and pays a share of the royalties to the inventors (Trolle, int., 2004). The other regions had similar patenting and licensing organisations but most of them had to close it down due to commercial failure. The process of finding a licensee is a difficult one and requires a lot of business competence and experience (Felix, int., 2004, Trolle, int., 2004).

Additional supportive actors such as business incubators and providers of seed-capital are of crucial importance. Most of the TBS in Sweden finance or run business incubators. Science parks seem to play an important role as well. Examples are Ideon in Lund and Mjärdevi Science Park in Linköping. There seems to be a particular network model that incorporates incubators, risk and seed capital and other public actors.

In general, success factors in all steps of patenting and commercialisation are capital and business competence according to most of the respondents.

The evaluation of technology bridging foundations and university holding companies in Sweden by the Swedish National Audit Office (RRV 2001) and own empirical observations give the impression that technol-

ogy bridging foundations and holding companies have been quite effective in building up infrastructures for the commercialisation of research results in general. Nevertheless, university patenting offices, such as Forskarpatent, were not as successful.

### 5.3.2 Infrastructure for commercialisation in Germany

The infrastructure for the commercialisation of university research in Germany is currently under development as a result of the abolishment of the university teachers' privilege. According to the Federal Ministry of Education and Research (BMBF) (2001, p. 4), "the reform of the university teachers' privilege and the establishment of patenting and exploitation agencies are directly interlinked: After the reform of the university teachers' privilege more scientists will have an incentive to have their inventions patented and will thus achieve commercial exploitation. This will also ensure better use of capacities and thus ensure more economic work of the agencies." Unfortunately, the BMBF does not provide the reader with empirical evidence why scientists should have incentives to patent their research results after the abolishment of the UTP.

In addition there is a network initiative to support academic spin-offs (EXIST).<sup>56</sup> There is even a programme that provides seed capital for students and academic staff (EXIST-Seed). Furthermore, there is another network initiative that aims at connecting research institutes with small and medium-sized enterprises.<sup>57</sup> In general, German R&D policy follows a network approach since the 1990s (Fier & Harhoff 2002).

There are twenty patent and exploitation agencies. Every Bundesland (federal state) has its own PVA that is responsible for all universities in the state.<sup>58</sup> The role of the patent and exploitation agencies is to give advice to the university and the inventors who want to patent. They negotiate the exploitation contracts between university and private industry. The Federal Ministry of Education and Research (BMBF) financially supports patent applications from universities and offers financial support in the case of legal disputes.<sup>59</sup> A number of PVAs, such as Provendis GmbH and ipal GmbH were established quite recently. Provendis GmbH was established in 2001 as daughter company of Zenit GmbH which is a consulting company owned by the federal state of North-Rhine Westphalia (NRW), a bank consortium, and a business association. Zenit GmbH is responsible for most of the public aid pro-

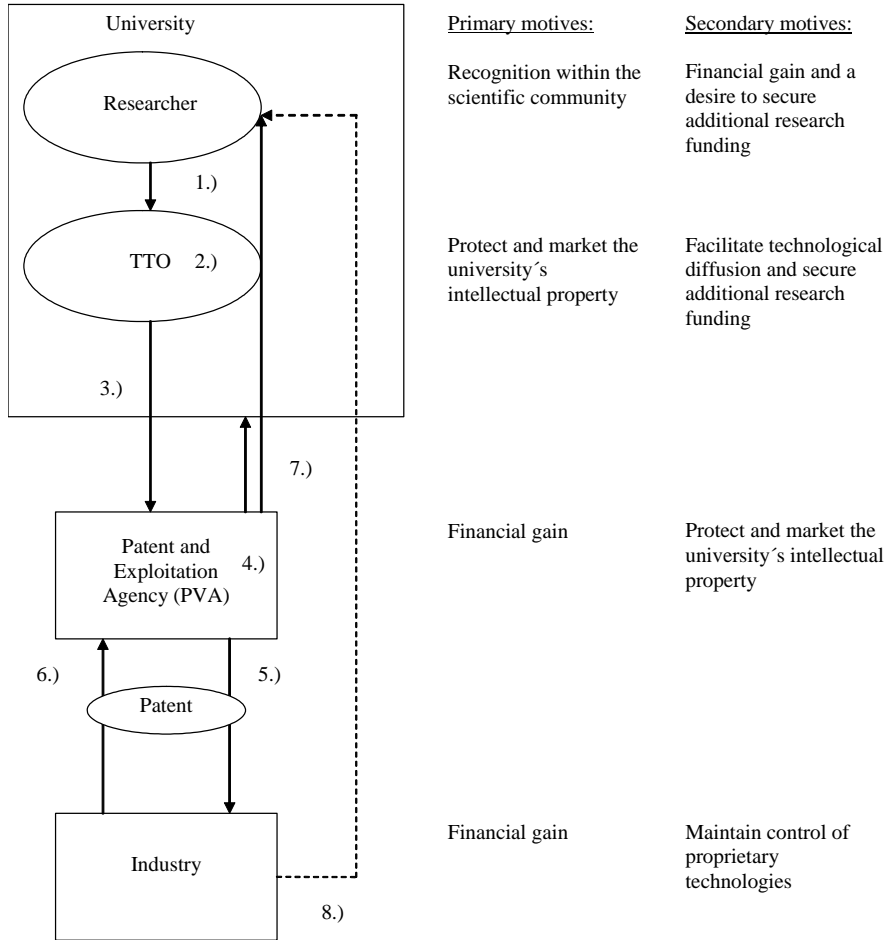
grammes in NRW. Ipal GmbH was founded in 2001 and is owned by the universities in Berlin and Investitionsbank Berlin (a public bank responsible for executing the public aid programmes in Berlin). In contrast, the PVAs in Hamburg (Tutech GmbH) and Karlsruhe (TLB GmbH) have longer experience with patenting and technology transfer. Tutech GmbH is owned by the technical university Hamburg-Harburg and was established in 1992. TLB GmbH emanated from a project at the university of Karlsruhe in 1987 and is owned by universities in Baden-Württemberg, the Fraunhofer Society and an industrial holding company.

In addition to PVAs, every university has its own technology transfer office (TTO). They offer advice and guidance. The TTOs are usually the first contact points of the researchers. They check the formalities of the invention disclosures and forward them to the PVAs. The PVAs are primarily responsible for the patenting and commercialisation process. PVAs are expected to finance themselves through royalty income in the medium term.

*A stylised model of the process of patenting and commercialisation in Germany*

Four German universities and their supporting infrastructures were studied in more detail. The following stylised model presents the common characteristics of the process of patenting and commercialisation of research results.<sup>60</sup>

Figure 3 A stylised model of the process of patenting and commercialisation of research results in Germany





We can distinguish between four different actors in Germany: the researchers, the TTO, the PVA, and industry. To understand the behaviour of the different actors, an elaboration on the motives is useful. The motives of the different actors draw on Siegel et al (1999). The primary motive of researchers is recognition within the scientific community. Secondary objectives are financial gain and in particular to secure additional research funding. The technology transfer offices (TTO) are dependent parts of the university. Their primary motive is to protect and market the university's intellectual property. Secondary motives are to facilitate technological diffusion and to secure additional research funding. The patent and exploitation agencies (PVA) are (mostly) independent from the university. The ownership structure of PVAs is likely to influence the objectives.<sup>61</sup> According to the respondents at the PVAs, the primary motive of PVAs is financial gain through licensing income. As a by-product, they connect the university with industry, which can secure additional research funding. Industry's primary motive is financial gain and to maintain control of proprietary technologies. The respondents at PVAs and TTOs indicate that it is very difficult to sell licenses. It seems that large enterprises are less willing to pay for licences from universities than small and medium-sized enterprises. A lot of firms that fund university research regard the IPRs in the inventions as part of the research contracts.

The federal regulation governing employees' inventions (§ 42,43 *Arbeitnehmererfindungsgesetz, ArbNErfG*) prescribes some process elements and deadlines. The process of patenting and commercialisation of university research is similar in all cases and can be illustrated with figure 3.<sup>62</sup>

1. The researcher submits an invention disclosure to the TTO.<sup>63</sup>
2. The TTO checks the invention disclosure with respect to formalities and completeness. It checks whether other parties (e.g., financing firms) already own the IPRs.
3. The invention disclosure is forwarded to the PVA. The PVA and the universities usually negotiate service contracts, which means that there is an obligation to contract. The PVA has the mandate to patent and commercialise the invention disclosures of the universities in the Bundesland.

4. The PVA assesses the invention with respect to property rights, technological and economic prospects and provides a recommendation to the university whether they should claim the invention or not. When the university does not claim the invention, the inventor receives a clearance by the university. That means the inventor becomes the owner of the invention.
5. In case of a claim of the university, the PVA protects the invention, usually through a patent application, and markets the invention, usually through licensing. The PVA bears all costs and they cover their expenses by royalty income.<sup>64</sup> The PVA identifies licensees and negotiates licensing contracts.
6. The licensee pays royalty fees to the PVA.
7. The PVA distributes the payments. The inventor receives 30% of the gross income. The surplus after covering of the costs is shared between the PVA and the university. The share of the PVA ranges between 30% and 50%. The share of the university flows usually back to the department of the inventor in the form of additional research funding, in some cases administrative overhead of 5 to 10% is deducted.
8. Most of the inventions emanating from universities are in a rather premature stage. Thus, further development of prototypes and alike is in many cases required. This can generate additional sponsored research.<sup>65</sup>

As shown in figure 3 above, the different stakeholders have different objectives. For researchers, recognition within the scientific community – usually accomplished through publications – is the primary objective. But acquisition of additional research funding is an important objective as well. Protection of the university's intellectual property and a financial gain from commercialisation is a major goal for TTOs. The TTOs are dependent administrative units at universities and they share the objective of the researchers in that sense that they appreciate the acquisition of additional research funds. In this context it is important to mention that a quite large share of the net profit from licensing flows back to the department of the inventor in the form of additional research funding. PVAs are (mostly) independent from universities and their primary reward is dependent on royalty revenue.<sup>66</sup> That means their primary

objective is financial gain from patenting and commercialisation of research results. Industry's objectives are financial gain and control of proprietary technologies. In case of firms funding research projects at universities, they often regard the inventions as part of the contract and are less willing to pay royalty for that (Rehberg, int., 2004).

## 5.4 Issues from the Interviews

A number of issues came up from the interviews that deserve more attention. This section of the paper summarizes the answers and concerns of the respondents. I avoid quoting the respondents directly because the interviews were conducted in Swedish and German. Only a summary of the answers is presented.

### 5.4.1 Issues from the German interviews

One important issue in Germany is the relation between publication, patent and external funding. Another important issue is the effect of the abolishment of the university teachers' privilege and the build-up of technology transfer infrastructure as perceived by TTOs and PVAs. Finally, spin-offs and patent costs are addressed. Those topics reveal the essence of the interview data.

#### *Publications, patents and external funding*

Publication, patents and external funding are intertwined with each other. These issues are heavily influenced by the reward structure of the researchers as conceived by the TTOs and PVAs.

The academic reward system constitutes a major factor that impacts on the incentives of academic researchers. According to Rehberg (int., 2003), a patent is increasingly regarded as an assessed publication and is increasing in status even for the scientific career. In Berlin, it is planned to incorporate patents as assessment criteria for the allocation of funds inside the university (Poppenheger, int., 2003). The recently introduced global budgeting gives the universities more freedom and autonomy to dispose over their resources. Patents become important for researchers inside the university as well. Karl (int., 2003) mentions that through the new system of wage negotiations, the universities are able to reward more productive researchers. This means, for instance, that universities can pay higher wages to researchers that apply for patents. Previously,

the wage structure for researchers was quite inflexible. Most of the respondents think that patents are important as signal for research competence to acquire external funding.<sup>67</sup> In sum, empirical evidence from the interviews suggests that there is no conflict between publication and patent. The new German regulation allows a publication to be delayed for up to two months.<sup>68</sup> Furthermore, patents are increasingly used to assess the performance of researchers inside the university. Patents are important to acquire external funding, not only from industrial sources but also from public sources as the new funding rules from the German Research Foundation (DFG) and the BMBF suggest. Patents and publications can be regarded as complementary, at least in technical subjects.

The impact of external funding on the incentives of researchers to patent and commercialise university research seems to be particularly important.

The total share of external funding ranges from 21% in Berlin to almost 35% in Karlsruhe. But there is a large variation with respect to subjects. The qualitative survey was not able to show a relation between external funding and commercial success (e.g., patents).<sup>69</sup>

Nevertheless, patents are important as indicator to attract external funding. As already mentioned, patents are regarded as a signal about the research competence.<sup>70</sup> Wegehaupt (int., 2003) mentions that the RWTH Aachen has the policy to safeguard jobs inside the university and outside the university. The most important means to safeguard jobs inside the university is through external funding whereas external jobs are created through licensing and spin-offs. Basically all respondents in universities in the chosen cases regard the acquisition of external funding as important. This is a vital part of a researcher's job. But the extent to which the PVAs focus on this issue varies. In Hamburg, the Tutech GmbH is responsible for the management of funded projects with private industry. They are also involved in the acquisition of funding for prototype building. In Karlsruhe, the TLB GmbH has nothing to do with the acquisition of external funds. Nevertheless, they assist when cooperation partners are sought for building prototypes. The same is true in Aachen, where the acquisition of external funding is only a by-product in the course of efforts to find licensees. In Berlin, the acquisition of external funding is not one of the tasks of the PVA. Nevertheless, cooperation contracts between the university and industrial firms are negotiated as

by-product in the course of commercialisation efforts. Schillert (int., 2003) argues that a general problem is that most of the inventions from universities are in the rather premature phase of an idea. It is very difficult to sell an idea and if they can sell the idea in an early stage of development the revenues are very low. Thus, further investments are required to develop the idea into a prototype or demo model. In this phase, Provendis GmbH tries to find an industrial partner that develops the invention further together with the university. In some cases, public funding is acquired for these kinds of collaborative projects. This kind of acquisition of external funding is a means to an end, namely to further develop the invention to increase the chances to sell a licence. The situation is similar in Hamburg and Karlsruhe. Thus, it seems that researchers' and universities' goal to attract external funding can be in conflict with the primary goal of the PVAs, the licensing of patents.

The assignment of patent rights to the funding enterprise is common practice in all cases, even after the abolishment of the UTP as interviews with German professors suggest. The universities do simply not have the capacity to control all external contacts and contracts. There are a lot of problems with respect to the negotiation of royalty payments and alike. In particular large enterprises refuse to pay an additional amount of money for the invention.

Nevertheless, industry is highly interested in collaborative research. Rehberg (int., 2003) answered that industry is funding university research because it is by far cheaper than in-house R&D. Furthermore, universities have human capital and competence that industry does not have. As such, industry is partly dependent on university research.

In sum, the interview answers related to publications, patents and external funding indicate that patent and publication are rather complementary. Patents are important to attract external funding. External funding increases the budget in terms of scientific staff<sup>71</sup> and equipment<sup>72</sup> of the researchers. Both aspects are likely to increase the chances to publish and to get cited. To attract external funding in particular from industry is therefore a vital part of the jobs of researchers at technical universities. This responds indirectly to the academic reward system as well. Thus, the academic and the commercial reward system are not really in conflict, at least in the technical subjects.

*The abolishment of the university teachers' privilege and the infrastructure*

The profit distribution is similar in all four cases. The inventor gets 30% of the gross revenue. The costs of patenting and commercialisation are not deducted. That means the inventor does not bear any costs or risks. This is mandatory in the new regulation governing employees' inventions. In Hamburg, Tutech GmbH and the university share the profits after all costs are covered equally. At the technical university Hamburg-Harburg the research group of the inventor receives the share of the university. Similar arrangements are in place in Aachen, Karlsruhe and Berlin. Thus, the department of the inventor receives the share of the university as kind of additional external funding.

The general tenor of the respondents is that the abolishment is likely to increase incentives of the researchers towards commercial exploitation of research results.<sup>73</sup> It has to be differentiated between a small fraction of researchers that were patent-active already before the abolishment of the university teachers' privilege and the vast majority of researchers that were not active in commercial exploitation. The former researchers are fighting against the new regulation and their incentives are likely to decrease. The latter ones are likely to be motivated by the abolishment of the university teachers' privilege (Schillert, int., 2003, Jung, int., 2003, Rehberg, int., 2003). Thus, most of the respondents argue that the balance between those with positive incentives and those with negative incentives after the abolishment of the UTP is still positive.

The new German regulation is not only valid for scholars like the former university teachers' privilege but also for researchers who did not become professors yet.<sup>74</sup> This is likely to vitalize technology transfer in general (Poppenheger, int., 2003). It is also important to note that the majority of the respondents had the opinion that it is mainly the improved infrastructure for commercialisation and not solely the abolishment of the university teachers' privilege that increases incentives for commercial exploitation (e.g., Kobek, int., 2003, Wegehaupt, int., 2003, Poppenheger, int., 2003).

Basically all respondents attested that the infrastructure for patenting and commercialisation of university research has improved a lot in Germany since the abolishment of the university teachers' privilege. Kobek (int., 2003) criticizes the obligation that the university has to pay 30% of gross

revenue to the inventor. This regulation can be disadvantageous for the university since the university has to bear the costs for patenting and commercial exploitation and that there is a risk that the university and the PVAs make losses whereas the researcher gains from commercial exploitation. This could reduce the number of claims of inventions by the university. Karl (int., 2003) notes that researchers in general are quite conservative. A lot of researchers are simply not interested in commercialisation issues.

#### *Spin-offs and patent costs*

Rehberg (int., 2004) argues that the spin-off phenomenon is overestimated. The primary focus of commercialisation is licensing (Jung, int., 2004, Rehberg, int., 2004). In those cases, where a start-up emanates from the university, newly examined students and PhD students are most prone to establish enterprises. In some cases, professors hold shares in the enterprises. There are different initiatives that promote start-ups. The public promotion programmes (e.g., EXIST) presume that the applicants do not hold positions at the university (Karl, int., 2003).

The overall impression from the interviews is that the costs of patenting are not particularly high. Every patent application requires a cost/benefit analysis. The patent costs do not hinder from applying for a patent according to the respondents. All four cases are supported by the support programmes of the BMBF. This means they receive subsidies for establishing PVAs and patent costs.

#### 5.4.2 Issues from the Swedish interviews

The qualitative analysis of the interviews revealed a number of important issues that are presented in this part of the paper. First, the relation between publications, patents and external funding are addressed. Second, the effects of the university teachers' privilege and the infrastructure are analysed. Finally, the importance of start-ups and spin-offs is shown. In general, the reader has to be aware of selection effects in Sweden. In Germany, external funding and licensing seems to be in conflict with each other. In Sweden, the TBS and holding companies have no information about external funding and IPRs since the researcher has full discretion about the use of her IPRs. Thus, the Swedish participants

of the interview study do only possess information about patenting and commercialisation in those cases where the scholars involve them.

*Publications, patents and external funding*

In general, publication is still the dominant means to disseminate research results. But it seems that patents become more important as merit even inside the university (Felix, int., 2004, Holm, int., 2004, Sjönell, int., 2004). In addition patents are getting more important to attract external funding, in particular from industrial sources (Carlsten, int., 2004, Varnestig, int., 2004). At Chalmers University of Technology, patents have strategic importance to increase the value of the “trademark” Chalmers and to attract the best researchers and funding (Carlsten, int., 2004, Felix, int., 2004). A number of respondents highlight that a rather large share of researchers’ time is related to writing funding applications and to attract funding. Thus, patents seem to increase in importance as academic merit and as a signal about research competence that can be used to acquire funding contracts.

*The university teachers’ privilege and the infrastructure*

As already mentioned, the UTP is a default rule. It is only valid in case of missing contractual arrangements. A number of respondents claimed that the discussion should focus more on the infrastructure for commercialisation than the UTP (Hegg, int., 2004, Trolle, int., 2004, Sjönell, int., 2004). Blomberg (int., 2004) argues that the supporting actors have to provide professional offers to the researchers. This is in line with Hegg (int., 2004) who claims that the question about an abolishment of the UTP is basically the wrong or irrelevant question. Important for patenting and commercialisation is capital and infrastructure. Wessman (int., 2004) argues that it is not necessary to abolish the UTP since it is a default rule. The actors can easily contract around the UTP. Supporting actors in the infrastructure can provide support in terms of capital, advice or incubator services in return for ownership shares in patents or enterprises. This is frequent practice. Most of the interviewees were of the opinion that it is quite costly to apply for and in particular to keep a patent and that this is a hinder for inventors to patent their inventions (Blomberg, int., 2004, Carlsten, int., 2004, Felix, int., 2004, Wessman, int., 2004, Ljunge, int., 2004, Hegg, int., 2004, Holm, int., 2004, Varnestig, int., 2004). Although Segerborg (int., 2004) thinks that the patent



costs should not deter a researcher from applying for a patent when the researcher is confident about the commercial potential. But in some regions, there exist scholarships and other grants that can be applied for to cover patent costs (e.g., in Gothenburg, Lund). Furthermore, the researchers can transfer their rights to other actors that take over patenting and commercialisation (e.g., Forskarpatent i Syd, Acceleratorn, some holding companies). Carlsten (int., 2004) emphasises the importance of a diverse commercialisation infrastructure. There are a lot of different ways to commercially exploit research results. There is no single optimal way. Sjönell (int., 2004) argues that the UTP is not very relevant if the supporting infrastructure works. The infrastructure is, therefore, the pivotal point with respect to patenting and commercialisation of research results from universities. Segerborg (int., 2004) argues in favour of an abolishment of the UTP since this would give incentives to the university to demand support. She brings forward the argument that the university itself should not build up infrastructure for commercialisation. The university should contract out those services. The whole innovation system would profit from that argues Segerborg. But as indicated by Felix (int., 2004) and Holm (int., 2004) it is unlikely that the infrastructure is able to generate profits. Another solution could be a national patent centre analogous to the German Max Planck patent office as proposed by Varnestig (int., 2004). Hult (int., 2003) suggests a similar centralised solution. Varnestig (int., 2004) argues that the investment in infrastructure for patenting and commercialisation seems to be profitable for the state but not for the university.<sup>75</sup> He claims that the state profits through increased employment and tax revenue. Revenue from licensing is highly skewed. Most of the university patenting offices (Forskarpatent) had to close down in Sweden because of low profitability. His proposal of a central patent office for all universities could pool the risks of patenting and licensing of university patents.

#### *Spin-offs and start-ups*

There are large selection effects in Sweden. In contrast to Germany, where the researchers have to notify the university in case of an invention, the researchers in Sweden can commercialise on their own. This means, the supporting infrastructure in Sweden does not possess information about all patenting and commercialisation efforts. An illustration is Varnestigs (int., 2004) statement that a large amount of patents come out of

KTH but that those patents are rarely commercialised through KTHs own infrastructure. Therefore, it is very difficult to make statements about the number of patents, licenses or spin-offs. Sjönell (int., 2004) claims that 5-10% of all commercialisation efforts are done through start-ups. Forskarpatent i Syd in Lund is quite active in selling licenses but until now there was not much of a financial backflow (Holm, int., 2004, Trolle, int., 2004). Chalmers Technology Licensing in Gothenburg is not really active anymore (Felix, int., 2004). A number of other respondents indicate that it is very difficult to sell patents or licenses in Sweden. One reason could be the rather small Swedish market. It seems that the majority of commercialisation efforts are directed towards the establishment of new enterprises. Varnestig (int., 2004) claims that it is difficult to earn money through patents and licenses. In recent years it was quite easy to attract risk capital for start-ups. This can partly explain the current trend of entrepreneurship. But it depends on the industry as well. Blomberg (int., 2004) and Holm (int., 2004) indicate that to sell patents or licenses is dominant in pharmaceuticals whereas a start-up is more interesting in industries based on technology and engineering. Holm (int., 2004) claims that the entry barriers are very high in the pharmaceutical industry which decreases the chances of a start-up.

<sup>40</sup> The structural factors will be included as control variables in the survey that will be conducted in the course of this project.

<sup>41</sup> From a methodological point of view, this chapter contains the qualitative analysis of the interviews. In chapter 6, the cases are analysed by resorting to economic theory.

<sup>42</sup> About 82% of public R&D is spent in universities according to the European Commission (2001, p. 210).

<sup>43</sup> According to VINNOVA (2003, p. 13), this “Swedish model” for techno-scientific research goes back to the 1940s. The university is society’s central research resource because this is supposed to be the best way to connect research with education. This is one of the reasons why Sweden has the highest share of R&D in relation to the GDP in the OECD countries.

<sup>44</sup> According to VINNOVA (2003b, p. 1), “during a 10-year period (1995-2005) Swedish industry and the Swedish government are making a joint investment of Euro 550 million on research collaboration in 28 competence centres at 8 universities”. This is about 1% of total annual R&D expenditures in Sweden. Industry pays about Euro 22 million/year, universities Euro 19 million/year, and VINNOVA and the Swedish Energy Agency Euro 19 million/year. On average 11 companies participate in each centre; 17 centres have applied for, or filed, 115 patents, 11 centres contributed to the start of 22 new companies.

<sup>45</sup> In the competence centres, the parties involved (university institute, industrial partners, VINNOVA, Swedish Energy Agency) negotiated different terms concerning IPR. The university teachers’ privilege is only valid if there are no contractual agreements.

<sup>46</sup> External funding as share of total funding in 2000 (Jonsson & Sörlin 2002, p. 111): Chalmers University of Technology, Gothenburg (72%), Stockholm School of Economics (Handelshögskolan i Stockholm) (70%), Royal Institute of Technology, Stockholm (KTH) (64%), Linköping University (58%), Lund University (52%), Swedish University of Agricultural Sciences (SLU) (51%), Uppsala University (48%), Göteborg University (46%), Stockholm University (41%), and Umeå University (39%).

<sup>47</sup> About 44.9% of public R&D is spent at universities and about 7.1% of public R&D is spent at technical universities (European Commission 2001, p. 130).

<sup>48</sup> The results for Max-Planck institutes and Fraunhofer institutes can be found in the appendix.

<sup>49</sup> For more details, see SOU 1996:70 and Glanberg 2000.

<sup>50</sup> There is no “grace period” in Swedish and German patent laws. A publication forecloses a patent application since it violates the novelty condition (see BMBF 2002).

<sup>51</sup> The situation is different for public research institutes, such as Fraunhofer institutes or Max-Planck institutes. In these cases, the research institutes already owned the patent rights before the abolishment of the university teachers’ privilege. As a result, these public institutes have been running their own technology transfer offices for a long time. Some of them, e.g., Garching Innovation, are quite successful (European Commission 2001, p. 154).

<sup>52</sup> The scholar can fully use the research results for publication after the submission of the patent application.

<sup>53</sup> Science parks are important for the establishment of new enterprises in general. They promote academic spin-offs as well, but since this paper elaborates on patenting of university research, the particular focus is on the university holding companies, the technology bridging foundations, and the university. Science parks are in frequent collaboration with the other public support actors, such as TBS and holding.

<sup>54</sup> It is also important to mention that these organisations should not compete with private organisations (RRV 2001, p. 39). That means in practice that public organisations such as university holding companies or technology bridging foundations should support collaboration with private industry unless there are private actors that could replace their efforts. This is especially important when it comes to risk capital.

<sup>55</sup> The characteristics of the four Swedish universities can be found in the appendix.

<sup>56</sup> EXIST (“Existenzgründungen aus Hochschulen”) started in 1997 as a competition between different regional networks. It seeks “to improve the entrepreneurial culture at higher-education institutions and to increase the number of companies started up from academic establishments” (BMBF 2000, p. 4). At least three different actors from a region had to collaborate, of which one actor had to be a higher education organisation. From 109 proposals for regional networks, 5 winner regions were selected and promoted with substantial financial resources. “Dresden exists” in Dresden and “KEIM” in Karlsruhe were honoured in 1999 by the EU as best thematic networks for the promotion of start-ups and growth of innovative businesses.

<sup>57</sup> In the InnoNet programme, small and medium-sized enterprises (SMEs) engage in collaborative research with research institutes. The SMEs finance 20% of the R&D expenditures of the research institute and receive the IPRs in the results. This kind of collaborative research is quite effective since not only codified knowledge in the form of patents is transferred but also tacit knowledge, which seems to be especially valuable when it comes to the application of research results. According to Belitz (2003), 37% of the research organisations in the InnoNet initiative were private research institutes (e.g., An-Institute), about 33% universities, and about 25% Fraunhofer institutes.

<sup>58</sup> Provendis GmbH is responsible for all universities in NRW. NRW has about 18 million inhabitants. TLB GmbH is responsible for all universities in Baden-Württemberg. Baden-Württemberg has about 10.5 million inhabitants. With respect to patenting and commercial exploitation, ipal GmbH is responsible for FU Berlin, Humboldt University Berlin, University of Applied Sciences Berlin, Technical University Berlin, FHTW University of Applied Sciences Berlin. Berlin has about 3.4 million inhabitants. Tutech is responsible for all universities in Hamburg. Hamburg has about 1.7 million inhabitants.

<sup>59</sup> The federal government subsidizes via its ministry of education and research (BMBF) the patenting costs of the PVAs. The BMBF pays 80% of the patenting costs in 2002 and 2003. Furthermore, the BMBF changed its funding policy with regard to technology transfer in that way that applications for research funding must include a clause about what happens with the research results (commercialisation plan). In

addition, a number of flanking initiatives have to be taken into account. One important change in the administration of the universities is the move from cameralistic accountancy (public service accounting) towards commercial accounting with the introduction of a so-called “Globalhaushalt” (global budget). This gives the universities more autonomy to allocate the funds between the different departments inside the university. Another legal change is the reform of the employment law regarding researchers at universities (*Dienstrechtsreform*). This reform opens the possibility for universities to attract researchers through wages that rise above the base salary. Previously, the base salary was fixed. The lowest wage for professors in Germany after the reform is about 4,500 € a month (*W3-Professors*). The university to attract top-level researchers can increase the wage above the base salary. Particularly at technical universities, professors are frequently recruited from leadership positions in private industry.

<sup>60</sup> The characteristics of the four German universities can be found in the appendix.

<sup>61</sup> One of the PVAs in the sample (Tutech GmbH) is fully owned by the university. One PVA (ipal GmbH) is partly owned by a public bank that supports regional development, the remaining shares are owned by the universities in the Bundesland. Two PVAs (Provendis GmbH and TLB GmbH) are partly owned by industrial associations, by universities, and the State.

<sup>62</sup> This reflects the federal legislation in relation to the abolishment of the university teachers’ privilege. It is also similar to the process of technology transfer at US American universities as presented in Carlsson & Fridh (2002).

<sup>63</sup> Even if there exists a legal obligation for the researcher to submit an invention disclosure, it is difficult to enforce this regulation. Evidence from the interviews in Germany suggests that some researchers do not care about the new regulation. They still negotiate external funding contracts that include clauses about IPR transfer. The situation is similar in the US, see Siegel et al. (1999). A huge bureaucracy would be needed to check all contracts. The RWTH Aachen has up to 4,000 external industrial funding contracts a year.

<sup>64</sup> In 2002 and 2003, the BMBF covered 80% of the patenting costs.

<sup>65</sup> According to Siegel et al. (1999), the role of patents is frequently overstated. Many firms acquire a technology before it is patented. Furthermore, according to Thursby et al. (2001, p. 71), “sponsored research is more likely to be included in a license agreement if the new technology is at an early stage of development or if the TTO values it as important.” The interviews in Germany confirm this. This can also explain the selection problems with respect to data collection in Sweden. This type of technology transfer does not show up in statistics.

<sup>66</sup> The PVAs in Germany received start-up financing from the federal government but they are expected to finance themselves in the medium-term since public subsidies will cease.

<sup>67</sup> This is supported by other empirical studies as well. According to Gering & Schmoch (2003), a major reason to seek patent protection for Fraunhofer institutes is to attract research grants and contracts. Patents are regarded as a signal about the research competence.

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<sup>68</sup> Most of the respondents do not regard the new regulation as a hinder for academic publications. Usually, the researchers can publish even faster since the PVAs work quite fast with the patent applications.

<sup>69</sup> In the course of my PhD thesis, a survey of researchers will be conducted. This can give major insights in this respect.

<sup>70</sup> This is in line with the results of a survey at German universities by Meyer-Krahmer & Schmoch (1998) who found out that a major motive for university researchers to cooperate with industrial firms is the acquisition of additional research funds.

<sup>71</sup> In particular PhD students which can lead to joint publications and citations by PhD students.

<sup>72</sup> In particular state-of-the-art equipment that can lead to higher quality of the scientific results which, in turn, can lead to publications in renowned journals.

<sup>73</sup> Of course, this has to be seen with caution. I interviewed primarily the “university-side” and the answers can be biased. The next step in this PhD project is a survey of researchers. This will enable a more balanced picture.

<sup>74</sup> All researchers (even PhD students) regardless their career status are entitled to 30% of the gross revenue. Before the abolishment of the university teachers’ privilege, only scholars (Hochschullehrer) were entitled to the IPRs.

<sup>75</sup> This is in line with empirical investigations in Sweden. Reitberger (1983) evaluated the public support by STU in the 1970s. The result was that one million SEK spent resulted in 1.5 to 2 million SEK in terms of taxes and duties. But the distribution of profits was highly skewed. Three successful projects (out of 2,000) have borne STU’s total investments in the 1970s (see also VINNOVA 2003).

## 6 Comparison of incentive structures

This chapter analyses the empirical material from the interviews by resorting to the theoretical framework presented in chapter 4. The first section (6.1) analyses the impact of the structural factors in both countries. Section 6.2 compares the effects of the property rights regimes in Sweden and Germany. It addresses, therefore, the primary research question “What are the incentive effects of patent regimes in the university?”. Section 6.3 analyses the effect that infrastructure has on agency costs and transaction costs in both countries. It addresses the second research question “What is the role of technology transfer offices?”. The analyses provide factors that are important for technology transfer (6.4).

### 6.1 The impact of structural factors: the science system

The science system can have a high impact on patenting and commercialisation activities. Particularly important are the academic reward system and the funding situation. When we compare the science systems of Sweden and Germany, a remarkable fact is that universities in both countries seem to fulfil slightly different tasks. Universities in Sweden conduct the major share of publicly funded R&D (82% of public R&D); whereas in Germany, the role of the university is much more narrow (52% of public R&D). Public research institutes play a significant role in Germany. A significant share of application-oriented research is done in institutes, such as Fraunhofer institutes. Universities in Germany seem to be more focused on basic research. A consequence of this orientation might be the substantially larger share of base funding. When we look at table 5 in the appendix (10.3.3), we see that Max-Planck institutes are heavily oriented towards basic research, receive the vast majority of funding in terms of base funding and industry funding is very low. As a consequence, the number of patent applications of Max Planck institutes is rather low (see figure 4 in appendix 10.3.4). In contrast, the Fraunhofer institutes are primarily oriented towards applied research, receive fairly limited resources from base funding and cover a quite large share of their budget through industry funding. This results in very active patenting behaviour. The universities are in between those extremes. Patenting of university researchers increased since the 1970s. One reason is the increasing total budget of universities but Gering & Schmoch (2003)

claim that increasing emphasis by universities on the technological exploitation of research results has gained importance as well.

When we now compare universities in Sweden and Germany, it seems that universities have different roles in both countries. Swedish universities have partly similar roles as non-university research institutes in Germany. This becomes even more evident when we take into account the competence centre programme in Sweden.<sup>76</sup>

Thus, qualitative evidence indicates that the structural factors, in particular the funding system and the organisation of the science system are likely to have an impact on patenting of research results. When comparing science systems one has to have in mind that a lot of statistical mistakes can distort the analysis. An illustrative example is the German An-Institutes as compared to the Swedish competence centres. An-Institutes are private or semi-public and not part of the university. Their performance will not show up in university statistics. In contrast, the national competence centres in Sweden fulfil a similar function in the Swedish science system but they are actually part of the university and their performance data will show up in university statistics.

## 6.2 The impact of property rights regimes

In **Sweden**, the researchers own the whole bundle of property rights. Especially important is the disposal right and the residual right. That means if Swedish scholars want to commercialise their results, they have to bear the costs associated with patenting and commercialisation (not the actual R&D costs that led to the invention) and receive the benefits from their research results. As already mentioned, two incentive effects have to be considered. First, the incentives of the researchers to engage in commercialisation efforts. Second, the incentives of the university to invest in exploitation infrastructure.

### *Incentives of the university in Sweden*

In Sweden, the university owns not even a share of the bundle of property rights, which means basically that the IPR regime provides no incentives to build up infrastructure for patenting and commercialisation. Nevertheless, we see a flourishing commercialisation infrastructure around most of the Swedish universities. This can primarily be explained by the investments of the central government in infrastructure. The TBS



and university holding companies received their initial funding not from the university but from the state. But, the Swedish IPR regime puts the responsibility for protecting IPRs in research results entirely on the researcher.

A number of respondents argued in favour of an abolishment of the university teachers' privilege (UTP) because this would provide incentives for the university to build up infrastructure and to be more active with respect to patenting and commercial exploitation (Segeberg, int., 2004). Varnestig (int., 2004) illustrates the problem with the hen and egg metaphor. An abolishment of the UTP requires very good infrastructure for commercialisation. But the development of a good infrastructure can only be justified if the UTP is abolished. Basically all interviewees in Sweden claimed that the commercialisation infrastructure is more important than the UTP.

#### *Incentives of the researcher in Sweden*

In the current situation the university has weak incentives to invest in infrastructure for patenting and commercialisation. The residual right, which is owned by the researcher, provides incentives to invest in the resource. The question arises whether this incentive is strong enough for university researchers. In this context it is important that the Swedish UTP is a default rule (dispositive law). According to Craswell (1999, p. 13), "a default rule, by definition, leaves parties free to specify some other rule to govern their relationship if they so choose". Thus, the bundle of property rights in research results includes even the freedom of contract. Economic theory assumes that "since voluntary transactions generally increase the welfare of all parties to the transaction, whenever a promise is voluntary it could be argued that welfare will usually be increased if the promise is carried out" (ibid., p. 18). Local decision-making based on contract law can be more efficient. As mentioned by Faure & Skogh (2003, p. 148), "indeed, the civil law of many countries is built on the premise that agreements reached in free contracting are beneficial not only to the individuals but also to society".

The researchers and other contract parties (e.g., industry, public funding agencies, TTOs, universities) can easily contract around the UTP if it is beneficial to the parties involved. Universities can actually abolish the UTP in contractual negotiations with researchers. In our context it is

important to note that contracts only increase welfare of the contract parties. The university is not always party to the contract with respect to patenting and commercial exploitation. Thus, it is possible that the university actually bears some costs of commercialisation – for instance, if researchers use university’s equipment for their private commercialisation purposes or if researchers neglect research and teaching since they devote their time to commercialisation – without receiving the benefits of commercialisation. As mentioned in the theoretical part of this paper, those externalities have to be taken into account.

Since the researcher is the owner of the research results in Sweden, she has full discretion about its use. If she expects a welfare gain by entering an agreement with the university holding or other supporting actors then she will probably do that. The researcher has different options:

1. Publication of the research results in scientific journals
2. Surrender of patent rights in return for funding
3. Exploitation of the invention.

The first option is the primary objective of most researchers according to a number of studies (e.g., Dasgupta & David 1994, Powell & Owen-Smith 1998, Siegel et al. 1999), since the academic reward system primarily rewards publication in renowned journals. Thus, the academic reward system provides strong incentives for publication. In case of no patent application industry can exploit this type of knowledge for free as a public good.<sup>77</sup>

The second option is to surrender the patent rights in return for funding. The empirical findings suggest that this is common practice in both countries. This is also in line with other empirical studies (Bercovitz et al. 2001, Thursby et al. 2001, Schild 1999).<sup>78</sup> It seems that transaction costs are rather low in this case. Researchers often have a number of contacts to industrial enterprises and the frontiers of research are probably known by private firms that want to finance research. The acquisition of additional research funds is one of the major motives for university researchers to co-operate with industrial firms according to Meyer-Krahmer & Schmoch (1998). Thus, researchers seem to have quite strong incentives towards this option.

The third option would be commercial exploitation. This can take different forms. Empirical evidence from Sweden indicates that in the technical subjects and pharmaceuticals a patent is the starting point. Patents are regarded as important by most of the respondents. The researcher has to pay the costs of patenting and commercialisation. The patent can then be sold or licensed or used as an asset in a start-up.

The interviews conducted in Sweden indicate that the infrastructure for commercialisation often focuses on start-up or spin-off. Varnestig (int., 2004) argues that one reason for that could be the negative experiences to earn money with licenses in Sweden and the easiness to attract risk capital for start-ups in the last years. Sjönell (int., 2004) indicates that the market for licenses in Sweden is rather small. The supporting infrastructure is a decisive factor for the commercialisation decision as interviews with researchers imply. The researchers can negotiate contracts with other agents. A frequent practice is that researchers surrender part of their ownership in patents or the start-ups in return for financial support. One frequent condition for attracting seed and risk capital is that patents or equity shares are transferred to the seed/risk capital company (Segeberg, int., 2004, Wessman, int., 2004).

*University teachers' privilege as default rule and the problem of externalities in Sweden*

The Swedish UTP has the advantage that if researchers want to patent and commercialise they can involve other supportive actors to get resources in terms of capital, guidance, and business competence. Competition between supporting actors can possibly increase the quality of the services. But the market does not provide most of those services and most of the actors in the supportive infrastructure are publicly financed. It seems that commercialisation of university research is not profitable – at least in the short and medium term – otherwise we would expect private provision of those services necessary for patenting and commercialisation. As developed in the theoretical part of this paper, one reason could be the high transaction costs in terms of uncertainty and asset specificity. This will be discussed in section 6.3.

A central property of the Swedish UTP is that it is a default rule (dispositive law). Swedish researchers own the residual right and the freedom of contract. This opens the possibility for voluntary agreements. But the

efficiency of voluntary agreements depends on externalities. Free contracting is only beneficial to the whole society if all externalities are internalised. That means that all costs and benefits associated with the commercialisation decision are taken into account by the scholar. This is hardly the case in Sweden. The researcher does not bear all costs since the R&D investments that led to the research result are paid by other parties. These can be public or private sources. The source of funding can determine the allocation of the residual right, for instance, if a firm that finances research claims the patent right. But external effects matter in this context. External effects occur if the profits from research (e.g., patents) are not internalized by the funding party or if the funding party internalizes the benefits without having to pay all costs. In this context, we have to distinguish between R&D costs and commercialisation costs.

R&D costs involve all costs that occur in the course of the “usual” research endeavour. This includes the direct costs of the project and the costs for research infrastructure (overhead costs). Overhead costs should not be neglected since they usually range between 30 and 50% of the project costs. Commercialisation costs include the subsequent costs that can arise in the course of commercialisation, such as patenting costs, costs of capital, costs of information, guidance etc. As written by Domeij (1998, p 13), the major costs of commercialisation occur after the patent application. The public discussion about the UTP focuses primarily on the fact that the majority of the public R&D is paid by public sources and that the whole society should benefit from research not only the individual researcher. Proponents of an abolishment of the UTP claim that it is rather the university – representing the public - that should receive the IPRs and profit from the R&D conducted at universities. But the distinction between R&D and commercialisation costs is usually neglected. This distinction is quite important since the interviews indicate that most of the inventions from universities are in a rather premature phase and need further development. Even those inventions that are already codified in the form of a patent need usually a lot of additional resources (in terms of seed capital, risk capital, business competence, guidance etc.) to be able to generate income for the party who owns it. So, even if the IPRs in research results are transferred to the university, the university has to invest heavily in those inventions until – if ever – it becomes profitable. Experience from Stanford University indicates that a

few “nuggets” generate profits whereas the vast majority of commercialisation projects does not even cover their costs. The infrastructure can reduce the commercialisation costs only. The following table 2 illustrates the externality argument.

Table 2 R&D costs, commercialisation costs, and the sources of funding

	Who covers R&D costs?	Who covers overhead costs?	Who covers commercialisation costs?	Who receives commercialisation benefits?
“typical” public base funding w/o IPR transfer	Public financier (mainly state)	Public financier (mainly state)	UTP is valid (S): researcher decides UTP not valid (D): University decides	UTP is valid (S): researcher decides UTP not valid (D): University decides
S: competence centres	Financiers (private and public)	Financiers (private and public)	If industry exploits: firms in the consortium	If industry exploits: firms in the consortium
D: non-university institutes (e.g., FhG, Max-Planck)	Financiers (private and public)	Financiers (private and public)	If invention is licensed: licensee/institute	If invention is licensed: licensee institute: royalty
“typical” industry funding with IPR transfer (depends on type of external funding)	Private financier (funding firm)	University (and financier depending on the agreement)	If industry exploits: the funding firm	If industry exploits: the funding firm, Uni: depends on “bonus” for IPRs Scholar: depends on “bonus” for IPRs
Industrial in-house R&D	Firm	Firm	Firm	Firm

“Typical” public funding, for instance, in the form of base funding does not involve transfer of IPRs. This type of funding covers usually R&D costs and overhead costs. The UTP is usually valid. This is the typical reference situation where the scholar, in case of commercial exploitation, has to bear all commercialisation costs and receives the entire benefits. The scholar has the possibility to transfer her IPRs to other parties (e.g., TBS, university holding company, private firms). This means, the residual right is transferred including the responsibility to bear costs of commercialisation and the possibility to receive the profits. At the other end of the spectrum, we see industrial R&D inside

private enterprises with own R&D departments. Those firms have to cover all costs of R&D and in case of commercial exploitation they bear all costs and receive the entire benefits. This case resembles an efficient property rights regime where all external effects are internalised. In between, mixed regimes are presented. Particularly interesting is “typical” industrial funding. This is often a grey area according to Segerborg (int., 2004). It depends on the agreement between researcher and financier whether externalities distort the efficient allocation of resources. Particularly interesting is whether industrial financiers cover all R&D costs including overhead costs. The university has to pay maintenance costs for the infrastructure, e.g., machinery and equipment. If the private financier pays for the R&D costs only, the university bears those overhead costs. The effect is that the university subsidizes research that is probably commercialised by industry. Furthermore, the efficiency of this type of funding depends on all agreements, including the university. Thus, it depends whether funding firms have to pay a kind of “bonus” to the inventor and the university for the invention, thus internalising those costs.

As already mentioned, the researcher bears the entire responsibility of commercialisation. The property rights regime in Sweden depends crucially on transaction costs. If property rights are wrongly assigned and transaction costs are too high to enable the resource “academic knowledge” to move to the party who values it the most, then commercialisation will not take place and the third mission will be neglected. But as Trolle (int., 2004) speculates, Sweden has the UTP and at the same time a quite strong record in academic start-ups, thus, transaction costs and the UTP do not seem to be a hinder. The impact of infrastructure will be analysed in 6.3.2.

In **Germany**, the new regulation regarding employees’ inventions abolishes the UTP. The bundle of property rights in research results changed content and ownership. It is now the university that holds the disposal right and the residual right. The freedom of contract with respect to technology transfer is transferred to the university as well.

#### *Incentives of the university in Germany*

In general, the residual right provides incentives to the university to establish commercialisation infrastructure. All researchers are obliged to submit an invention disclosure to the university. The university has the

right to claim the inventions. Thus, the commercialisation infrastructure should receive all university inventions. But most of the universities have an obligation to contract with “their” PVA.<sup>79</sup> They cannot use alternative actors, e.g., the patent offices of Fraunhofer society or Max-Planck society. According to BMBF (2001), this should ensure more economic work of the agencies. Please note that the supporting infrastructure in Germany is primarily financed by public sources but the PVAs are expected to finance themselves in the medium term.

The residual right of the university is limited since the inventor receives 30% of the gross revenue. Some respondents claim that the compulsory compensation to the inventor reduces university’s incentives to engage in commercial exploitation because it means that the university can make losses whereas the researcher can only gain by commercialisation (Kobek, int., 2003). This puts a lot of emphasis on the infrastructure to select inventions. Fleuchaus and Braitmayer (2002, p. 655) indicate that the university has to generate proceeds of at least 43,000 € to avoid a loss since a patent application can easily cost 30,000 €

#### *Incentives of the researcher in Germany*

The researcher receives 30% of the gross revenue in case of successful commercialisation. The costs of patenting and commercial exploitation are not deducted. This means that, in case of successful commercialisation, the researcher receives a quite generous compensation without bearing any costs or risks. The interviews in Germany indicate that we have to distinguish between two groups of researchers. For those researchers, who were previously commercialising their inventions on their own, the new regulation is likely to decrease their incentives to submit an invention disclosure. For those researchers who were not engaged in commercialisation efforts, the new regulation is likely to increase the incentives to submit an invention disclosure to the university.

#### *The problem of externalities and enforcement in Germany*

As already mentioned, it is now the university that holds the residual right and the freedom of contract with respect to IPRs in research results. That means the current practice that researchers surrender IPRs in research results in return for funding is not legal anymore. The university should be involved in those negotiations. With respect to table 2, this

means that the university will try to take part in those negotiations – even if it will be difficult for the university to control all contracts between scholars and firms. Universities will try to get all R&D costs (including overhead costs) covered, thus making the funding firm internalising all costs. At the same time, universities try to receive a share of the commercialisation benefits from the firms. Recently, standard form contracts for contract research and collaborative research (known as “Berliner Verträge”) were developed.<sup>80</sup>

In general, the new regulation could mean higher costs for private financiers of research. It depends on the possibilities of universities to negotiate with industry and the elasticity of demand of the funding firms whether this will lead to reduced demand of contract research. But as the interviews in Germany indicate, the enforcement of the regulation is rather difficult. It seems to be difficult to hinder a researcher – in particular those that hold lifelong tenure – from entering an agreement with private industry. Empirical evidence from the US points in the same direction (Siegel et al 1999).

In general, it is likely that the assignment of property rights to the university decreases transaction costs. The process of commercialisation is prescribed by law. This reduces uncertainty for the researchers. Since the researchers have no discretion, the responsibility for commercialisation is transferred to the actors in the infrastructure, in particular the PVAs. Whether the infrastructure in Germany is able to reduce agency and transaction costs is analysed in 6.3.1.

The comparison of Germany and Sweden shows that the assignment of property rights in research results determines the incentives of researchers and universities to commercially exploit research results and to invest in infrastructure for patenting and commercialisation. In Sweden, the researchers own the freedom of contract, which leads to a diversity of transfer channels and approaches. But since transaction costs – in particular uncertainty and asset specificity – are very high, we cannot expect a market provision through private actors of those services necessary for patenting and commercialisation. This can explain why the vast majority of infrastructure is publicly financed. In Germany, there is not much variety with respect to transfer options. Universities have long-term contracts with “their” PVA. Private provision of transfer services is absent – possibly because of high transaction costs.



Infrastructure for patenting and commercialisation seems to be a decisive factor in both countries. We have to have in mind that the reward for the third mission is affected by property rights and infrastructure. In Germany, the property rights regime decreases incentives of those scholars who were previously commercialising on their own. But the new regime provides incentives to researchers who were not actively involved in commercialisation before. Compensation in case of commercialisation is quite generous which can reduce the incentives of universities/PVAs to engage in commercialisation efforts. For both groups, incentives for the third mission depend on the success of the PVAs in commercialising research results. In Sweden, the actors in the infrastructure have to raise awareness and attract inventors to engage in patenting and commercialisation efforts.

### **6.3 The impact of the supporting infrastructure**

In a world with transaction costs the assignment of property rights matters. The previous analysis has shown that infrastructure is a decisive factor that impacts on the incentives to patent university research results in both countries. This section analyses whether the infrastructure in Germany and Sweden is able to reduce transaction costs. If actors in the supporting infrastructure are not able to reduce the transaction costs of patenting and commercialisation, the expected reward for the third mission will be low in comparison to the other two missions. This affects the agency costs as well, since the outcome of the third mission has an impact on the allocation of time and effort of the researcher. High transaction costs of patenting and commercialisation reduce the reward for the third mission, which reduce the incentives of scholars to put effort into third mission activities.

#### **6.3.1 Does the infrastructure in Germany reduce transaction costs?**

In general, the development of infrastructure – in particular the establishment of patent and exploitation agencies – has a number of advantages that decrease transaction costs. At the same time the single focus of PVAs on royalty neglects external funding and increases the agency costs. The arguments are developed in turn.

1. Centralized PVAs reduce uncertainty through pooling of risks
  2. Centralized PVAs ensure the returns of specific investments
  3. PVAs focus on royalty only and increase agency costs.
1. Every Bundesland has its own PVA that is responsible for a number of universities. This centralized organisation decreases uncertainty that is an important market factor and determinant of transaction costs according to Williamson (1985). As shown above, commercialisation of university research is a highly uncertain process. Only a minority of inventions from universities will ever generate profits. Without means to reduce transaction costs (in particular uncertainty), the expected value of efforts associated with the third mission is very low. Thus, researchers would have an incentive to simply neglect commercialisation since the rewards for the other missions are higher.<sup>81</sup> One finding of the interview study was that only a small fraction of university researchers considers commercialisation. Even if the university owns the IPRs, they are still dependent on “input” from the scholars in the form of invention disclosures. With respect to uncertainty, the PVAs in Germany decrease transaction costs since centralized PVAs have a kind of insurance function since they actually pool the risks associated with a large number of inventions in each Bundesland. This increases the expected value of the third mission since it increases the probabilities to get inventions that generate profits. In addition, centralized organisation of commercialisation efforts increases also the profitability of the PVA since economies of scale are likely to occur.
  2. Transaction costs in terms of asset specificity have to be taken into account as well. Commercialisation of university research requires specific competence and knowledge as the interviews indicate. The costs of commercialisation infrastructure are quite high and only a large number of commercialisation projects can justify specific investments in those “dedicated assets” in Williamson’s sense. Universities have usually long-term contracts, sometimes even an obligation to contract with their specific PVA. This safeguards the enforcement of returns on transaction specific investments for the

PVA. Thus, since PVAs are in a kind of monopoly position they have incentives to build up infrastructure.

3. But as the interviews in Germany suggest, this monopoly position comes at a cost as well. The entire focus on commercialisation by most of the PVAs increases actually the agency costs. A number of respondents highlighted the importance of the trade-off between royalty income and external private funding. In case of high external private funding, the demands on the funding enterprise with respect to royalties can be lower (Wegehaupt, int., 2003).<sup>82</sup> Basically all respondents uttered the importance of acquisition of external funds for the researchers and the university. This is in line with the findings from Bercovitz et al (2001, p. 31), “faculty, particularly those in materials sciences, engineering and/or agricultural sciences, are reported to be accepting of this trade-off valuing immediate support of ongoing research (and importantly, the funding of graduate students) over licensing returns.” Bercovitz et al (2001) identify organisational structure as a possible hinder for this trade-off. According to Bercovitz et al (2001), organisational variables affect the relative productivity of university technology and licensing operations.

Thus, it seems that the trade-off between external funding and royalty income could hinder commercialisation of research results in Germany. The remaining part of this section will, therefore, focus on this issue.

Empirical evidence suggests that with a matrix organisation leveraging (the trade-off between royalty rate/licensing fees and sponsored research dollars) will be greatest but that the reward system does not support this in some cases (Bercovitz et al 2001). When we look at the German cases, Tutech GmbH in Hamburg comes pretty close to a matrix organisation. Tutech incorporates the patent and exploitation agency, a contract research unit, incubator services, and it promotes spin-offs and start-ups. As such, all revenues generated through the different activities flow to Tutech regardless whether it is royalty income generated through the PVA or income from research funding through its contract research unit. Most of the externally-funded research projects from industry are managed by Tutech GmbH. Tutech receives about 10% of the research grant as overhead. As such, Tutech has a vital interest in the acquisition of external funds. In contrast, the recently founded PVAs ipal GmbH and

Provendis GmbH regard themselves as pure business enterprises (Jung, int., 2003, Schillert, int., 2003). In Berlin, contacts to other supporting agents, such as venture capitalists, are only provided if the PVA profits from it (Jung, int., 2003). It has no interest in other types of incomes that can be generated for the university through commercialisation of research results. That means universities that have a densely integrated network with respect to technology transfer are likely to have advantages in attracting private external funding and alike.

In other words, the service contracts that rule the relation between the PVA and the university are important. If the rewards of the PVA depend solely on royalty income, the PVA will focus on licensing only and not on other goals such as the acquisition of external funding. According to Rehberg (int., 2003), the integration and linkages between the different activities at Tutech GmbH is the only way that makes the PVA cost neutral for the university. Furthermore, the PVAs have high pressure to refinance themselves in the medium term. The major goal of most PVAs is to sell licences to generate royalty income.

Important factors that are likely to have impact on the strategies of PVAs are ownership and membership in different boards of directors.<sup>83</sup> A number of cross-overs can be identified in the different regions. A problem with respect to agency costs can occur if the PVA focuses entirely on royalty whereas the primary commercialisation strategy of the researcher is through industrial collaboration. If the commercialisation infrastructure – in particular the PVA - is not able to mediate between the partly conflicting modes of transfer, it is likely that researchers avoid submitting invention disclosures and simply neglecting the third mission. This is possible because universities do not have the capacity to fully control their researchers. The costs of control are too high for the university.

Commercialisation infrastructure has an impact on transaction costs and agency costs. PVAs that focus on patenting and commercialisation only disturb researchers' incentive to attract external private funding, which has an impact on research output. The one-sided focus of some PVAs decreases their acceptance as interviews with researchers indicate. Since most of the universities cannot screen all contracts with private industry, the enforcement of the obligation of the researchers to notify the university about inventions is very difficult.<sup>84</sup> This shows one more time that

the researchers have informational advantages against the university that is very typical for a principal-agent problem.

With respect to transaction costs it depends on the ability of the PVA to commercialise research results. As mentioned by Bercovitz et al (2001), institutional history seems to play an important role for technology transfer. History matters and it seems that the ability of the technology transfer network to deal with the different incentive conflicts is further developed in older or more developed networks. TLB GmbH emanated from a project launched in 1987. Tutech GmbH was established in 1992. Provendis GmbH and ipal GmbH were established in 2001 and are still in a very early phase of development. The main strategy of commercialisation is to sell patents or licenses. The PVAs in the sample are rather cautious with respect to start-ups.

In sum, the infrastructure for patenting and commercialisation of university research in Germany faces a trade-off between transaction costs and agency costs. PVAs decrease transaction costs with respect to uncertainty since they pool the risks of a number of different universities. A central PVA has greater chances to achieve economies of scale than a local one. In addition, the monopoly position of each PVA in each Bundesland (through obligation to contract by the universities) decreases transaction costs since it reduces the risk of opportunism and enforces the returns on transaction specific investments of the PVA. Thus, the central PVA has a quite strong position and has incentives to patent and commercialise for the universities. But the entire focus on royalty income from licensing by most of the PVAs can cause conflicts. PVAs neglect the acquisition of external funding as an important goal of researcher and university.

### 6.3.2 Does the infrastructure in Sweden reduce transaction costs?

In Germany, the actors in the supporting infrastructure are responsible for commercialisation. In Sweden, the researcher bears this responsibility. Other actors are only involved if the researcher enters a voluntary agreement with them. As already mentioned, property rights regimes in universities affect the incentives of the researchers to commercialise and of the university (or other supporting actors) to invest in commercialisation infrastructure. Researchers in Sweden are likely to involve supporting actors only if they expect a gain from this – as compared to using

other actors or not commercialising at all. As already shown, the frequent practice to surrender IPRs in research results in return for private external funding entails rather low transaction costs for the researcher, which makes this an attractive option.

In those regions with a well-developed infrastructure, researchers seem to be keener on collaborating with supporting agents. The researcher is only collaborating with other agents in case of expected benefits. The supporting actors have to offer good conditions to the scholars. Otherwise the researchers would not collaborate. Some respondents raised the issue that the possible abolishment of the UTP is the wrong question. It is rather the infrastructure that has to be developed so that those supporting actors can make reasonable offers to the researchers (e.g., Blomberg, int., 2004).

The interviews indicate that good practice in support covers competence and knowledge and, of course, financial resources. Financial resources are needed for the patenting process, for recruiting competent staff in the supporting infrastructure, for investments in start-ups (pre-seed capital, seed capital, risk capital). With respect to the theoretical framework used in this paper, the financial resources required for patenting and commercialisation are invested in specific assets. TTOs and organisations like Forskarpatent need dedicated assets in the form of a specialised organisation and human assets since the whole process of patenting and commercialisation requires well-trained personnel with business competence and an understanding of academia. But those specific investments are only taking place if the returns can be safeguarded. In a regime with UTP, as in Sweden, this is difficult to achieve. Thus, even if universities invest in infrastructure for patenting and commercialisation, it is not assured that those investments can be covered by future profits, since the researchers do not have to use the services of the actors in the infrastructure. Thus, incentives for investing in specific assets are weak in the first place.

In general, the analysis of infrastructure in Sweden remains inconclusive. There is a lot of regional differentiation. It seems that the infrastructures for patenting and commercialisation of university research in Lund and around Chalmers University of Technology work quite well. This is reflected by Carlsten's statement (int., 2004) who claims that Chalmers' infrastructure is so well developed that they could handle the

commercialisation process in case of an abolishment of the UTP. In Lund, Holm (int., 2004) was not so optimistic. He regards the infrastructure for commercialisation in Lund to be well developed, but not sufficient for dealing with all university inventions. In Linköping, Ljunge (int., 2003) and Segerborg (int., 2004) claim that the collaboration between the different supporting actors works quite well. Nevertheless, Ljunge argues that the infrastructure is not able to handle all inventions from the university. In Stockholm, the infrastructure seems to be more scattered and less integrated.

In relation to the theoretical argumentation of this paper, a number of factors that impact on transaction costs and agency costs have to be considered:

Uncertainty is evident as in the German case. The researchers themselves can reduce uncertainty by selling their results to industry. The question is whether the infrastructure in Sweden is able to reduce uncertainty and thus, transaction costs.

The current organisation of patenting and commercialisation has a number of properties:

1. Variety of approaches
  2. Local organisation
  3. Agency costs.
1. The analysis of infrastructure for patenting and commercialisation of university research in Sweden has shown a variety of different actors and transfer channels. Local organisation has the advantage that it increases the adjustment to local circumstances and needs. TBS have very different roles in the different regions. But there is no real market solution. All actors receive public funding.
  2. Every university has its own approach to patenting and commercialisation. The advantage in terms of adjustment to local needs comes at the cost of small-scale organisations. Uncertainty with respect to patenting and commercialisation is very high, reflected by a skewed distribution of royalty income. It is unlikely that the local infrastructure in Sweden is able to pool the risks associated with the patenting and commercialisation of university in-

ventions and to increase the expected value of the third mission. The commercial failure of most Swedish university patenting offices (*Forskarpatent*) indicates that there seems to be a lack of critical mass with respect to university inventions on the regional level. This means also that the local organisation is not likely to achieve economies of scale. But this is, of course, related to the UTP and the fact that scholars in Sweden do not have to involve the local organisations. Nevertheless, the success of some transfer organisations shows that it is possible to establish organisations that promote start-ups. It seems that in the case of start-ups, the supporting actors are able to ensure returns of investments in specific assets (through transfer of ownership in patents or enterprises). The organisation of support of start-ups can be organised on a small scale basis, as contrasted to patenting and licensing of university inventions. In all regions studied, there are well-developed structures for support of start-ups in the form of incubator services, and often even seed and risk capital. As Varnestig (int., 2004) claims, it seems to be easier to increase economic value with start-ups in contrast to patenting and licensing. Uncertainty seems to be lower. Another reason why the Swedish supporting actors focus primarily on start-ups could be the tendency that licenses (or options) are frequently assigned to industrial enterprises even before a technology is patented.<sup>85</sup> As mentioned by Thursby et al. (2001, p. 71), those licensing agreements frequently involve additional industrial external funding for the researchers. This type of technology transfer happens far away from the supporting infrastructure because of the UTP.

3. The current organisation of technology transfer in combination with the UTP avoids conflicts between external funding and royalty income. This is related to the freedom of contract. Licensing and funding contracts are negotiated without the supporting infrastructure and without the university. In a lot of cases, it is likely that conflicts are avoided because the researcher simply publishes without taking into account the third mission. Whether this is efficient depends on the externalities as shown in the previous section.



#### 6.4 Factors that are important for technology transfer

The whole phenomenon of patenting and commercialisation of university research should be viewed with caution. This type of technology transfer is often regarded as a kind of panacea to solve two broader economic problems. First, technology transfer can lead to economic and employment growth. Second, it can generate income to universities, researchers, and the state. This requires some clarification. No one really doubts that university research had an impact on economic development in the past. But to generate income from university research is a highly risky business. Transaction costs in terms of uncertainty and asset specificity are particularly high which precludes market provision. The infrastructure in Sweden and Germany is primarily financed by public sources. This indicates that patenting and commercialisation of university research is not profitable for the university in the short and medium term. But this does not mean that it could not be profitable for the state in terms of generated employment, taxes, duties and alike as other studies indicate (Reitberger 1983).

Nevertheless, the analysis of patenting and commercialisation of research results from universities in Sweden and Germany revealed a number of factors that are important for technology transfer in general.

Three broader factors are important. These can be summarized under the headings structural factors, the IPR regime, and supportive factors.

1. Structural factors have to be acknowledged. The organisation of the whole science system impacts on technology transfer in general. Competence centres in Sweden and An-Institutes in Germany generate different incentives to patent and commercialise than “traditional” institutes that conduct primarily basic research funded by public base funds.
2. Property rights in research results are an important issue. The situation in Germany actually blocks commercialisation options for researchers. In Sweden, university and researcher can abolish the UTP by contract. In practice, the university scholars rarely own their IPRs since a number of financiers require the university and the researchers to contract around the UTP (e.g., EU, Mistra, VINNOVA). Thus, it is frequently contracted around the university teachers’ privilege in Sweden. Further, the property rights regime

does not only provide incentives to researchers but to the university as well. In Sweden, the property rights regime provides weak incentives to universities to invest in commercial exploitation since they cannot reap the benefits. In contrast, German universities and the PVAs have incentives to invest in infrastructure. With respect to patents, patents become important as indicator for research output. Patents can be included as assessment criteria for positions in academia. Financiers of research at universities can actually steer this by acknowledging patents as merits.

3. Supportive factors in the form of infrastructure for patenting and commercialisation of results from university research are decisive. A centralized organisation of technology transfer is likely to reduce transaction costs associated with commercialisation of university research. In particular uncertainty has to be considered and a centralized organisation is able to pool the risks of failure associated with a large number of inventions. A centralized organisation increases the incentives of TTOs and alike to invest in specific assets needed to commercialise research results. Without UTP – as in Germany – the PVAs receive all invention disclosures from their partner universities. This increases the chances of the PVAs to re-finance themselves and to cover their investments. But even in Sweden – with UTP – a centralized organisation could decrease uncertainty and transaction costs. This could make it attractive to researchers to engage voluntarily in contracts with the TTO. A large number of contracts with researchers would increase the chances that the TTO receives the returns from their specific investments in infrastructure. Furthermore, infrastructure that is organised in a matrix organisation is likely to decrease incentive conflicts and agency costs. This enables cross-overs and links the different supportive actors, such as PVA, contract research unit, incubators, seed capitalists etc.

<sup>76</sup> A similar approach exists in Germany with the so-called “An-Institutes”. Those institutes are independent bodies at universities. They are completely private or semi-public. They perform application-oriented research and depend almost entirely on private and public research contracts. The model of the An-Institutes is comparable to that of Fraunhofer institutes.

<sup>77</sup> A public good is characterized by non-rivalry and non-excludability. In the past, global knowledge spillovers of public research were limited since the research results were usually published in the national language only. Increasing dissemination of results in English and increasing personal mobility of researchers and industry makes knowledge a global public good. Since university research is assumed to have a high impact on national competitiveness, most countries try to privatise university research results. A different approach would be to acknowledge the public good character of university research and provide global or supra-national funding of public research. One move in that direction is the planned introduction of the European Research Council (ERC) that should finance basic research in the European Union.

<sup>78</sup> University researchers and other parties, for instances financiers, like private enterprises or foundations, can easily contract around the university teacher privilege. They can draft contracts that make research grants and funds dependent on the transfer of intellectual property rights. Schild (1999, p. 95) in a study about patenting at Linköping University shows that only 23 out of 99 patents are owned by individuals, whereas 59 patents are owned by firms. In the competence centres in Sweden, the researchers that participate have to surrender their ownership rights. Own empirical evidence from interviews in Sweden and Germany confirms this.

<sup>79</sup> Ownership of the PVA is important in this context.

<sup>80</sup> The “Berliner Verträge” is a framework for research funding contracts with respect to IPRs. It was developed by a working group consisting of a number of large enterprises, the universities in Berlin and ipal GmbH. In case of contract research, the funding enterprise receives the IPRs and has to bear all costs. The university and the funding firm together apply for patent protection. The university receives the research costs and 2,500 € per patent and further payments in case of successful commercialisation. The inventors receive compensation in accordance with legal obligations (that means 30% of gross revenue). The “Berliner Verträge” can act as a kind of model or frame for research contracts at other universities as well.

<sup>81</sup> Please note that the reward of each activity depends on its relative costs and benefits. The productivity of each task is important in this context.

<sup>82</sup> In general, university research is quite cheap for the industrial firms in Germany since the universities usually do not calculate on a full cost basis. Firms pay frequently only the R&D costs. Thus, overhead costs and infrastructure are usually not covered in contract research agreements. Wegehaupt (int., 2003) mentions that the demands in terms of royalty can be lower if the firm paid more than the R&D costs.

<sup>83</sup> Institutions and incentives are also important from a network perspective. A number of different public promotion programmes exist in relation to commercialisation of university research, spin-offs, special programmes for small and medium-sized enterprises and so on. Knowledge about these sources of information and resources is

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important for the success of technology transfer and commercial development. It is therefore interesting to have a look at the linkages of the PVAs to other supporting agents. In case of Aachen, the responsible PVA Provendis GmbH is owned by Zenit GmbH. Zenit is responsible for a large array of public promotion programmes.<sup>83</sup> In Berlin, ipal GmbH is the daughter of Investitionsbank Berlin, which in turn is responsible for most of the public promotion programmes in Berlin. In Aachen and Berlin the mother companies of the PVAs are both responsible for public promotion programmes. Thus, it seems that access to the public promotion programmes is provided by the PVAs. It is also important to look at the linkages to other supportive actors such as business incubators, seed and risk capitalists and alike. In Hamburg, the Tutech GmbH incorporates a business incubator as well. Furthermore, Tutech provides services regarding contract research and promotion of spin-offs. One particular characteristic of Tutech is that it provides a whole range of supportive services in-house. In Karlsruhe, founders of enterprises are embedded in the KEIM network and there is access to business incubator services (Technologiefabrik).

<sup>84</sup> Wegehaupt (int., 2003) claims that RWTH Aachen has up to 4,000 industrial funding projects per year, which makes a screening of every single project with respect to IPRs impossible.

<sup>85</sup> See Thursby et al. (2001) for a similar argument.

## 7 Conclusion and policy implications

This paper assessed the impact of patent regulation in universities in Germany and Sweden on the incentives to patent research results. In particular, two broader research questions were addressed. 1. What are the incentive effects of patent regimes in the university? 2. What is the role of technology transfer offices?

In general, patent rights regimes in universities are very important. They can provide incentives to researchers and the university to invest in commercial exploitation.

In **Sweden**, the scholars own the research results. The university teachers' privilege is a default rule, which means it is only valid in case of missing contractual agreements. In reality, the researchers rarely own their research results since a lot of funding organisations require that the UTP is contracted around in their projects. It is a frequent practice that patent rights are surrendered in return for funding. In general, the freedom of contract that Swedish researchers enjoy opens for voluntary agreements with funding agencies, firms, supportive actors (TBS, university holding company, venture capitalists etc.). Voluntary agreements are only beneficial to society if all externalities are internalised in those agreements. External effects can occur if the profits from research are not internalised by the funding party or if funding enterprises internalise the benefits from public research without having to pay all costs (e.g., overhead costs). In this context, it was distinguished between R&D costs and commercialisation costs. This distinction is quite important since the interviews indicate that most of the inventions from universities are in a rather premature phase and need further development. So, even if the IPRs in research results are transferred to the university, the university has to invest heavily in those inventions until – if ever – it becomes profitable. The infrastructure can reduce the commercialisation costs only. The current property rights regime provides weak incentives to universities to invest in commercialisation infrastructure.

With respect to the role of technology transfer offices in Sweden, there is a lot of regional differentiation. In general, supportive actors such as TBS or university holding company are only involved if they can offer conditions that are favourable to the researchers, otherwise the research-

ers simply neglect the public infrastructure. The local and regional organisation of transfer infrastructure in Sweden is not able to reduce the transaction costs of technology transfer since the small scale organisations cannot pool the commercial risks associated with the patenting and commercialisation of university inventions. This is especially important with respect to patenting and licensing of university inventions. They cannot achieve economies of scale. Nevertheless, the local organisation is well adjusted to local circumstances which seems to be particular important with respect to the promotion of start-ups. There exists well developed infrastructure in the form of incubators, business advice and guidance, sometimes even seed and risk capital in all regions studied.

In **Germany**, the university owns the IPRs in research results. This provides incentives to universities to invest in commercial exploitation. Technology transfer is rather centralized in Germany with (mostly) independent patent and exploitation agencies. This is likely to reduce uncertainty and transaction costs through a pooling of the commercial risks associated with the patenting and commercialisation of a large number of university inventions. The centralized organisation is likely to achieve economies of scale. The PVAs have service contracts, often even an obligation to contract, with the different universities in the Bundesland (federal state). The compensation to researchers in case of commercial exploitation is quite generous. But whether this provides incentives to researchers to submit their invention disclosures to the university and the PVA is not sure since some PVAs focus entirely on royalty income and neglect the other major objective of both university and researchers, namely the acquisition of external funding. It is difficult to strictly enforce the new IPR regulation since the university has not the capacity to control all contracts the researchers negotiate with other parties, such as private firms.

Some **lessons for economic policy** can be drawn. In general, two things have to be done to increase the commercial output of university research. First, the agency costs inside the university have to be reduced. This means the reward structures have to be more balanced rewarding not only research but also transfer activities. One direct instrument to increase the rewards of transfer is to recognize patents as merit with respect to appointments of professorships and research positions. The acquisition of research funding is a vital part of a researcher's job, thus,

private and public funding agencies could foster commercial orientation by introducing patents as assessment criteria besides publications. Furthermore, the transaction costs of patenting and commercialisation have to be reduced. Commercialisation of university research is a highly uncertain business. Uncertainty is a major factor responsible for high transaction costs. There are not just information asymmetries – meaning that one party has more knowledge and information than other parties – but real uncertainty with respect to the outcomes of transfer activities. This, of course, impacts on the rewards for the third mission and on the trade-off between the different activities inside universities. Infrastructure for patenting and commercialisation is the pivotal element. A well-working infrastructure decreases transaction costs and provides incentives to engage in the third mission.

In **Sweden**, an abolishment of the UTP would require heavy investments in infrastructure. The analysis of commercialisation infrastructure showed that the current organisation is quite well developed but unlikely to be able to handle all university inventions in case of an abolishment. A transfer of the IPRs in research results to the universities would provide incentives to them to invest in infrastructure. But the high uncertainty associated with commercialisation of university inventions and the required high specific investments in infrastructure makes a decentralized organisation less promising. A centralised patenting and licensing office could pool the risks and lower the transaction costs of technology transfer. Good examples in this context are the central patent and licensing offices of Fraunhofer Society and Max-Planck Society in Germany. On the other hand, without abolishment of the UTP, selection effects can occur. That means there is a risk that the “good” inventions are commercialised by other means whereas the mediocre inventions end up in the public technology transfer offices. With respect to academic start-ups, it seems that the current local infrastructure is quite well developed and successful.

In **Germany**, it is too early to provide an elaborate analysis of the effects of the abolishment of the university teachers’ privilege. Nevertheless, it seems that the rather centralized organisation of technology transfer has a number of advantages. The generous compensation to inventors and the centralized organisation of transfer are likely to increase the outcomes of patenting and commercialisation not only for universities but

for the researchers as well. The infrastructure could possibly be improved by further centralisation. One patenting and licensing office for all technical universities, thus pooling the similar risks of commercial exploitation of a large number of inventions from technical universities, could further decrease uncertainty and transaction costs. But whether researchers submit their invention disclosures to the university depends on the acceptance of the PVAs by researchers. Most of the PVAs focus entirely on royalty and neglect acquisition of external funds, which is likely to cause conflicts with researchers. A matrix organisation of technology transfer that takes into account acquisition of external funding and other services, such as business incubators, could improve the situation.



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## Executive Summary

Knowledge is the most important source of long-term economic growth. Not surprisingly, as key sites both for research into new fields and for the training of future researchers and skilled personnel, universities and other higher education institutions have found themselves inevitably drawn into the modern national policy arena. But even if universities are increasingly regarded as important engines of technological development and economic growth, the share of governmental funds to universities is declining in the advanced countries in the last two decades. Universities are expected to interact more frequently with private industry and to adapt more to its needs. Especially concerning codified knowledge in the form of patents the system of intellectual property rights (IPR) is of paramount importance. It determines in universities who owns the resource “academic knowledge” and influences the incentives to exploit research results. In many countries the inventions resulting from publicly-funded research are owned by the university scholars. This is the so-called “university teachers’ privilege” (UTP). In Germany, the university teachers’ privilege was abolished in 2002, accompanied by support for the establishment of a network of patent and exploitation agencies (PVAs). In Sweden, the university teachers’ privilege still exists. Since 1997, the universities have the “third mission” on their agenda.

The purpose of this paper is to assess the impact of patent regulation in universities in Germany and Sweden on the incentives to patent research results. This paper presents a comparative analysis of patent rights regimes in universities in Germany and Sweden. The qualitative empirical study is based on 23 interviews in Germany and Sweden. It assesses the infrastructure for patenting and commercialisation in four university regions in Sweden and four university regions in Germany. This study applies institutional economics in that way that it elaborates on agency costs inside universities and transaction costs of commercialisation. Furthermore, this paper distinguishes between R&D costs and commercialisation costs and hints at the importance of differentiating between state and the university. Property rights theory is applied to show that costs and benefits occur on different levels and are borne/received by different parties.

The whole phenomenon of patenting and commercialisation of university research should be viewed with caution. This type of technology transfer is often regarded as a kind of panacea to solve two broader economic problems. First, technology transfer can lead to economic and employment growth. Second, it can generate income to universities, researchers, and the state. This requires some clarification. No one really doubts that university research had an impact on economic development in the past. But to generate income from university research is a highly risky business. The transaction costs of patenting and commercialisation of university research in terms of uncertainty and asset specificity are particularly high. High transaction costs generally preclude market provision of those transfer services. The infrastructure in Sweden and Germany is primarily financed by public sources. This indicates that patenting and commercialisation of university research is not profitable in the short and medium term. But this does not mean that it could not be profitable for the state in terms of generated employment, taxes, duties and alike as other studies indicate.

Nevertheless, the analysis of patenting and commercialisation of research results from universities in Sweden and Germany revealed a number of factors that are important for technology transfer in general.

Three broader factors are important. These can be summarized under the headings structural factors, the IPR regime, and supportive factors.

1. Structural factors have to be acknowledged. The organisation of the whole science system impacts on technology transfer in general. Competence centres in Sweden and An-Institutes in Germany generate different incentives to commercialise than “traditional” institutes that conduct primarily basic research funded by public base funds.
2. Property rights in research results is an important issue. The situation in Germany actually blocks commercialisation options for researchers. In Sweden, university and researcher can abolish the UTP by contract. In practice, the university scholars rarely own their IPRs since a number of financiers require the university and the researchers to contract around the UTP (e.g., EU, Mistra, VINNOVA). Thus, it is frequently contracted around the university teachers’ privilege in Sweden. Further, the property rights regime

does not only provide incentives to researchers but to the university as well. In Sweden, the property rights regime provides weak incentives to universities to invest in commercial exploitation since they cannot reap the benefits. In contrast, German universities and the PVAs have incentives to invest in infrastructure. With respect to patents, patents become important as indicator for research output. Patents can be included as assessment criteria for positions in academia. Financiers of research at universities can actually steer this by acknowledging patents as merits.

3. Supportive factors in the form of infrastructure for patenting and commercialisation of results from university research are decisive. A centralized organisation of technology transfer is likely to reduce transaction costs associated with commercialisation of university research. In particular uncertainty has to be considered and a centralized organisation is able to pool the risks of failure associated with a large number of inventions. A centralized organisation increases the incentives of TTOs and alike to invest in specific assets needed to commercialise research results. Without UTP – as in Germany – the PVAs receive all invention disclosures from their partner universities. This increases the chances of the PVAs to re-finance themselves and to cover their investments. But even in Sweden – with UTP – a centralized organisation could decrease uncertainty and transaction costs. This could make it attractive to researchers to engage voluntarily in contracts with the TTO. A large number of contracts with researchers would increase the chances that the TTO receives the returns from their specific investments in infrastructure. Furthermore, infrastructure that is organised in a matrix organisation is likely to decrease incentive conflicts and agency costs. This enables cross-overs and links the different supportive actors, such as PVA, contract research unit, incubators, seed capitalists etc.

Some **lessons for economic policy** can be drawn. In general, two things have to be done to increase the commercial output of university research. First, the agency costs inside the university have to be reduced. This means the reward structures have to be more balanced rewarding not only research but also transfer activities. One direct instrument to increase the rewards of transfer is to recognize patents as merit with re-

spect to appointments of professorships and research positions. The acquisition of research funding is a vital part of a researcher's job, thus, private and public funding agencies could foster commercial orientation by introducing patents as assessment criteria besides publications. Furthermore, the transaction costs of patenting and commercialisation have to be reduced. Commercialisation of university research is a highly uncertain business. Uncertainty is a major factor responsible for high transaction costs. There are not just information asymmetries – meaning that one party has more knowledge and information than other parties – but real uncertainty with respect to the outcomes of transfer activities. This, of course, impacts on the rewards for the third mission and on the trade-off between the different activities inside universities. Infrastructure for patenting and commercialisation is the pivotal element. A well-working infrastructure decreases transaction costs and provides incentives to engage in the third mission.

In **Sweden**, an abolishment of the UTP would require heavy investments in infrastructure. The analysis of commercialisation infrastructure showed that the current organisation is quite well developed but unlikely to be able to handle all university inventions in case of an abolishment. A transfer of the IPRs in research results to the universities would provide incentives to them to invest in infrastructure. But the high uncertainty associated with commercialisation of university inventions and the required high specific investments in infrastructure makes a decentralised organisation less promising. A centralised patenting and licensing office could pool the risks and lower the transaction costs of technology transfer. Good examples in this context are the central patent and licensing offices of Fraunhofer Society and Max-Planck Society in Germany. On the other hand, without abolishment of the UTP, selection effects can occur. That means there is a risk that the “good” inventions are commercialised by other means whereas the mediocre inventions end up in the public technology transfer offices. With respect to academic start-ups, it seems that the current local infrastructure is quite well developed and successful.

In **Germany**, it is too early to provide an elaborate analysis of the effects of the abolishment of the university teachers' privilege. Nevertheless, it seems that the rather centralized organisation of technology transfer has a number of advantages. The generous compensation to inventors and

the centralized organisation of transfer are likely to increase the outcomes of patenting and commercialisation not only for universities but for the researchers as well. The infrastructure could possibly be improved by further centralisation. One patenting and licensing office for all technical universities, thus pooling the similar risks of commercial exploitation of a large number of inventions from technical universities, could further decrease uncertainty and transaction costs. But whether researchers submit their invention disclosures to the university depends on the acceptance of the PVAs by researchers. Most of the PVAs focus entirely on royalty and neglect acquisition of external funds, which is likely to cause conflicts with researchers. A matrix organisation of technology transfer that takes into account acquisition of external funding and other services, such as business incubators, could improve the situation.





## Sammanfattning och slutsatser

Denna rapport behandlar äganderättens betydelse för incitament till patentering av forskningsresultat vid svenska och tyska universitet. I synnerhet två övergripande frågor har studerats:

1. Hur påverkar äganderätten till forskningsresultat incitamentsstrukturen vid universiteten?
2. Vilken roll spelar olika teknikspridningsaktörer?

Generellt kan man hävda att äganderätt till forskningsresultat är av stor betydelse. Äganderätt kan skapa incitament till kommersialisering och utnyttjande av forskningsresultaten.

I Sverige äger forskarna rätten till forskningsresultaten – detta kallas för ”lärarundantaget”. Det så kallade lärarundantaget gäller bara så länge inget annat avtalats i särskilda kontrakt eller överenskommelser. I praktiken innebär detta att det är ovanligt att forskarna äger sina resultat, då många finansiärer kräver rätten till resultaten. Det är således vanligt att äganderätten ges upp till förmån för finansiering. Systemet innebär att frivilliga överenskommelser blir vanliga, med exempelvis forskningsfinansiärer, företag eller stödinstitutioner (teknikbrotstiftelser, holdingbolag, riskkapitalister med flera). Sådana frivilliga överenskommelser är bara samhällsekonomiskt lönsamma så länge dessa internaliserar eventuella externa effekter. Externa effekter uppträder till exempel när vinster från forskning inte tillfaller forskningsfinansiärerna eller om finansiärer skördar frukterna utan att bära investeringskostnaderna (t.ex. overhead-kostnader). I detta sammanhang skiljer man mellan FoU-kostnader och kommersialiseringskostnader. Detta är en viktig distinktion då många av intervjuerna visade att merparten av universitetssprungna uppfinningar befinner sig i ett tidigt skede som ofta kräver vidareutveckling. Även om äganderätten överförs till universiteten innebär detta ändå fortsatt behov av stora investeringar från universitetens sida för att om möjligt nå kommersiell lönsamhet för uppfinningarna. En väl fungerande infrastruktur kan reducera kommersialiseringskostnaderna. Det nuvarande systemet ger endast svaga incitament till universiteten att investera i infrastruktur för kommersialisering av forskningsresultat.

När det gäller infrastruktur för teknikspridning finns det i Sverige stora regionala skillnader. Teknikbrostiftelserna och andra stödstrukturer blir i huvudsak inblandade endast om de kan erbjuda förmånliga villkor för forskarna, i övriga fall kringgår forskarna denna typ av offentliga infrastruktur. Lokala och regionala stödstrukturer har i Sverige svårt att minska transaktionskostnaderna för tekniköverföring eftersom dessa är för små för att sprida riskerna på det sätt som krävs när det gäller patentering. Detta gäller särskilt upptäckter och forskningsresultat som härrör ur universitetsforskning. Här uppnås inga skalfördelar. Detta till trots är de lokala organisationerna väl anpassade till lokala förhållanden, vilket i sin tur förefaller betydelsefullt för att stödja nyetableringar av företag. Inkubatorer, affärsrådgivning och annat stöd, ibland även sådd- och riskkapital, är väl utvecklade i alla studerade regioner.

I Tyskland är det universiteten som äger rättigheterna till forskningsresultaten. Detta stärker universitetens incitament till kommersiell exploatering. Organiseringen av tekniköverföring är i Tyskland relativt centraliserad med vanligtvis oberoende patent- och kommersialiseringsbyråer (PVA). Centraliseringen minskar osäkerheten och därmed transaktionskostnaderna genom att riskerna sprids på flera projekt, vilket även innebär skalfördelar. Patent- och kommersialiseringsbyråerna har kontrakt med universiteten – och ibland också en skyldighet att samarbeta med universiteten inom respektive förbundsstat. Ersättningen till forskarna vid framgångsrik kommersialisering är förhållandevis generös. Det är däremot inte säkert att detta ökar forskarnas incitament att anmäla uppfinningar till universiteten eller PVA, då PVA helt fokuserar på royalties och bortser från betydelsen av att forskningsresultaten också kan ge ”inkomster” i form av nya forskningsanslag. Det är också svårt att tillämpa de nya äganderättsreglerna då universiteten saknar kapacitet att kontrollera alla kontrakt som forskarna ingår med andra parter, exempelvis privata företag.

Några slutsatser för forsknings- och innovationspolitiken kan dras. På ett övergripande plan krävs två faktorer för att öka forskningens kommersiella utbyte. För det första krävs att den organisatoriska kostnaden i universiteten minskar. Detta innebär att belöningsstrukturen måste bättre balansera kunskapsöverföring och kommersialisering, såsom fallet är med forskningen. Ett instrument att öka belöningen är att erkänna patent som en merit vid tjänstetillsättningar. Att säkra finansiering för fortsatt

forskning är en viktig del i forskarens arbete, och här skulle både offentliga och privata finansiärer kunna använda patentmättet som ett av finansieringskriterierna. Vidare krävs att transaktionskostnaderna vid patentering och kommersialisering minskar. Kommersialisering av forskning är ett högriskprojekt. Här finns både informationsasymmetrier och genuin osäkerhet. Detta påverkar naturligtvis belöningen för forskarna vad gäller den tredje uppgiften och balansen mellan de olika aktiviteterna inom universiteten. Patenterings- och kommersialiseringsinfrastrukturen är nyckeln i detta arbete. En väl fungerande infrastruktur minskar transaktionskostnaderna och kan skapa incitament för att engagera sig i den tredje uppgiften.

I Sverige skulle ett upphävande av lärarundantaget kräva betydande investeringar i en sådan infrastruktur. Den nuvarande organisationen fungerar idag, men analysen av kommersialiseringsinfrastrukturen visade att det troligen inte klara ett upphävande av lärarundantaget. Om rätten till forskningsresultaten överförs till universiteten skulle det betyda ökade incitament för de att investera i nödvändig infrastruktur. Men den stora osäkerheten som är förknippad med kommersialisering av forskning i kombination med behovet av mycket specifik infrastruktur gör att en decentraliserad organisation kan få problem. En centraliserad licensierings- och patenteringsfunktion sprider risker och reducerar transaktionskostnaderna. Goda exempel i sammanhanget är de centrala funktionerna för Fraunhofer-Gesellschaft och Max-Planck-Gesellschaft i Tyskland. Väljer man däremot att inte avskaffa lärarundantaget kan selektionseffekter uppstå. Det skulle kunna innebära att de mest lovande projekten sugts upp av den privata sektorn medan mer mediokra projekt tas om hand vid de offentligt finansierade tekniköverföringsinstitutionerna. Ser man till nyetableringar av företag fungerar dock den nuvarande lokala infrastrukturen förhållandevis väl.

För Tysklands del är det ännu för tidigt för en mer definitiv analys av effekterna av lärarundantagets avskaffande. Trots det ser vi den centraliserade strukturen för teknikspridning som lyckad och rymmande flera fördelar. Den generösa ersättningen till forskarna och den centraliserade organisationen kommer sannolikt att öka resultat av kommersialiseringsansträngningarna både för forskarna och för universiteten. Ytterligare centralisering kan sannolikt förstärka dessa tendenser. En gemensam patenterings- och licensieringsfunktion för alla tekniska universitet kan

reducera osäkerheten och transaktionskostnaderna ytterligare. Viktigt är att forskarna anmäla sina uppfinningar till universiteten. Detta kräver att PVA accepteras av forskarna. De flesta PVA fokuserar idag helt på royalties och bortser från vikten av att attrahera nya anslag från externa finansiärer, något som kan orsaka spänningar mellan PVA och forskarna. Här skulle någon form av matrisorganisation, som både ser till betydelsen av fortsatt finansiering och till andra typer av tjänster, kunna förbättra situationen.

## Appendix

### The hypotheses

*Hypothesis 1:* Incentives to patent and commercialise university research are weak in research organisations with high base funding and high employment security.

*Hypothesis 2:* Incentives to patent and commercialise university research are stronger in applied research than in basic research.

*Hypothesis 3:* The academic reward system provides weak incentives to patent and commercialise university research.

*Hypothesis 4:* Ownership of research results by researchers leads to strong incentives for university researchers to patent and commercialise university research.

*Hypothesis 5:* The high costs of a patent application weaken the incentives to patent and commercialise university research.

*Hypothesis 6:* The possibility to attract external funding (in particular from industry) through a transfer of intellectual property rights for the research results provides strong incentives to patent and commercialise university research.

*Hypothesis 7:* The employment situation for senior researchers (professors) in universities provides weak incentives to patent and commercialise university research.

*Hypothesis 8:* Supporting infrastructure increases incentives to patent and commercialise university research.

## Interview guide

This is the translation of the interview guide. The questions were originally posed in German and Swedish to avoid interpretation mistakes.

### *List of questions 1: The role of the organisation*

- Which role does your organisation play in technology transfer in general and in particular in relation to patenting and commercialisation of research results from university?
- Which other actors do exist? Do the different actors compete or collaborate?
- Please explain the process of patenting and commercial exploitation from your perspective. Distinguish between patenting & commercialisation!
- Does a good infrastructure for commercialisation increase the incentives of the researchers to patent and commercially exploit research results? How does effective infrastructure look like?
- How is your organisation funded?

### *List of questions 2: The role of the IPR regime*

- Which role does the IPR regime play?
- Does the university teacher privilege (in Sweden) / the abolishment of the university teacher privilege (in Germany) create incentives to patent and commercialise university research?
- Only in S: Do you think the university teacher privilege should be abolished?
- Only in S: What should replace the university teachers' privilege?
  - Why would that be better?
- Only in S: How does the UTP create incentives to patent and commercialise?
- What happens with IPRs in case of externally funded research projects? Distinguish between different sources of external funding (private vs. public financiers).
- What happens with IPRs in case of industry funding?

*List of questions 3: Costs and benefits of patenting and commercial exploitation*

- How committed are the researchers during patenting and commercial exploitation?
- Does the full ownership (in Sweden) / the part ownership (in Germany) of the research results provide incentives to patent and commercially exploit research results?
- Do the patent costs hinder from applying for a patent?
- Who bears the costs?
- How do you assess the inventions? How are possible revenues calculated?
- How large is the share of patents in your portfolio that generates revenues?
- How are licencees identified?
- Is the industry interested in single patents from universities?

*List of questions 4: publication vs. patent*

- Which role does commercial success play for the career of researchers?
- What is the status of a patent for the career of the researcher?

*List of questions 5: External funding*

- Why is industry funding research at universities?
- Is it better to found a new enterprise for commercial exploitation or to sell a licence to an existing enterprise?
- Is there a risk that a firm acquires a licence to avoid competition from other firms? That means the firm acquires a licence to avoid commercial exploitation by other enterprises.

*List of questions 6: Academic start-ups and spin-offs*

- How is patenting and commercial exploitation financed? Distinguish between patenting and commercial exploitation.
- Is there access to seed capital? Private or public?
- Is there access to risk capital?
- How many spin-offs and start-ups did you have in the last years?
- Who founds new enterprises? (Professors/students/PhD students, entrepreneurs etc.)
- How and under which conditions does the university promote start-ups or spin-offs?
- Who else is promoting start-ups and spin-offs?

*Supplementary questions:*

- How could the process of patenting and commercial exploitation of research results be improved?
- What works particularly well or bad?
- Important quantitative indicators:
- How many patent applications? By whom?
- How many invention disclosures?
- How many employees in your organisation are working with patenting and commercial exploitation?
- How many patents generate revenue?
- How large is your budget in your organisation for patenting and commercial exploitation?
- How are the revenues/profits from licenses shared?



## Details of the German cases

### Structural characteristics of the four German universities

Table 3 Key figures about the chosen universities in Germany

	RWTH Aachen	Uni Karlsruhe	TU HH	TU Berlin
Foundation	1870	1825	1978	1879
Students (total)	28608	14942	4901	28933
- medicine/vet. med.	10%	n.a.	n.a.	n.a.
- math/natural sciences	24%	33%	10%	21%
- law/econ./soc. sciences	13%	18%	13%	21%
- language/culture	13%	7%	n.a.	19%
- engineering	39%	38%	77%	31%
- other	1%	3%	n.a.	8%
Professors (total)	387	275	139	360
Other academic staff	1787	821	348	1820
Non-academic staff	2197	1184	607	2320
Staff funded from external sources	1708	1347	317	961
- of which academic staff	n.a.	1078	286	824
Total staff (w/o professors emeritus, student assistants and trainees)	6,079	3,627	1,411	4,500
Expenditures (total)	428 mill €	239.6 mill €	74,5 mill €	343 mill €
External funding	129 mill €	82.8 mill €	20,5 mill €	72.8 mill €
External funding (share)	30%	34.6%	27.5%	21%
Invention disclosures	2002: 38 2003: 68	n.a.	n.a.	2002: 16
Inventions claimed (patents applied)	2002: 19 2003: 32	n.a.	n.a.	2002: 6

Source: Berghoff et al. 2003 & data from the websites of the universities. Expenditure and funding data Aachen: 2001, Hamburg: 2002, Berlin: staff data 2003, budget data 2002, Karlsruhe: 2002. Note that in the case of Berlin, the staff numbers are totals including externally funded personnel.

## Structural characteristics of the four German PVAs

Table 4 Some structural characteristics of German patent and exploitation agencies (PVAs).

	<b>TuTech</b>	<b>Ipai</b>	<b>TLB</b>	<b>PROvendis</b>
Invention disclosures since abolishment of the privilege (2002)	70	2002: 91	200/year	2002: 200
Patent applications	50	2002: 42	1999: 35 2000: 35 2001: 26 2002: 47	2002: 55
Negotiated licenses	n.a.	n.a.	1999: 25 2000: 17 2001: 8 2002: 17	n.a.
License income	n.a.	n.a.	1999: 638 T€ 2000: 389 T€ 2001: 361 T€ 2002: 557 T€	n.a.
Staff	4 Innovation managers	9 Project managers	10 Innovation managers	10 PROvendis
Foundation	1992	2001	1998 (1987)	2001
Federal state	Hamburg: 1.7 mill	Berlin: 3.4 mill	Baden-Württemberg: 10.5 mill	North-Rhine Westphalia: 18 mill

Source: interviews and secondary material.

## The German system of scientific research

Table 5 Some structural features in the German system of scientific research. Modified from Czarnitzki et al (2000)

	Max-Planck Institutes (MPG)	Universities/ Technical Universities	Fraunhofer Institutes (FhG)
Research in natural sciences & engineering	91.2%	38.8%	97.1%
Basic research orientation	88%	57%/38%	14%
Base funding	80%	65%	25%
Industry funding (share of total budget)	2%	7%/11%	40%
Intensity of Personnel mobility	27%	40%/35%	23%

### Statistical data on patent protection in German research institutes

Patent data of German universities and research institutes (Gering & Schmoch 2003, p. 80)

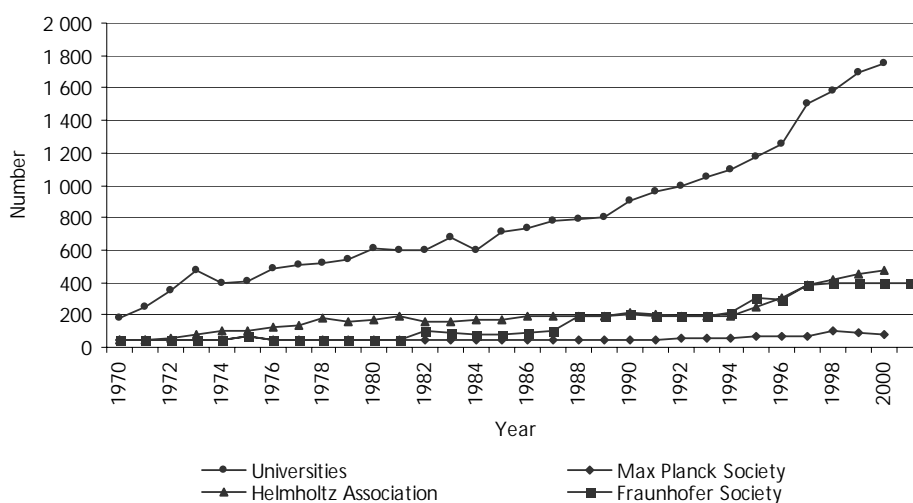
Gering and Schmoch (2003) conducted an analysis of patenting at German universities and research institutes. The volumes of R&D carried out by these institutions is universities EUR 7.9 billion of R&D in 1999, Helmholtz Association EUR 2.3 billion, Max Planck Society EUR 1.0 billion and Fraunhofer Society EUR 0.7 billion.

From a methodological point of view it is not possible to provide reliable statistics on university patents and licences in Germany according to Gering & Schmoch. Until the abolishment of the university teachers' privilege the professors privately owned their inventions. But nevertheless, "it is possible to provide quite reliable statistics on inventions made by professors because in Germany the title "professor" is exclusively used for university professors, and they generally use it in official documents." (Gering & Schmoch 2003, p. 80). Patent databases can therefore searched for the title „professor“ in the inventor category.

However, it is not possible to compute licence income of universities, as this information is generally not centralised or collected in a systematic way. It can also be assumed that a survey of all German professors would not lead to reliable information, as they might not be willing to disclose sensitive personal data.

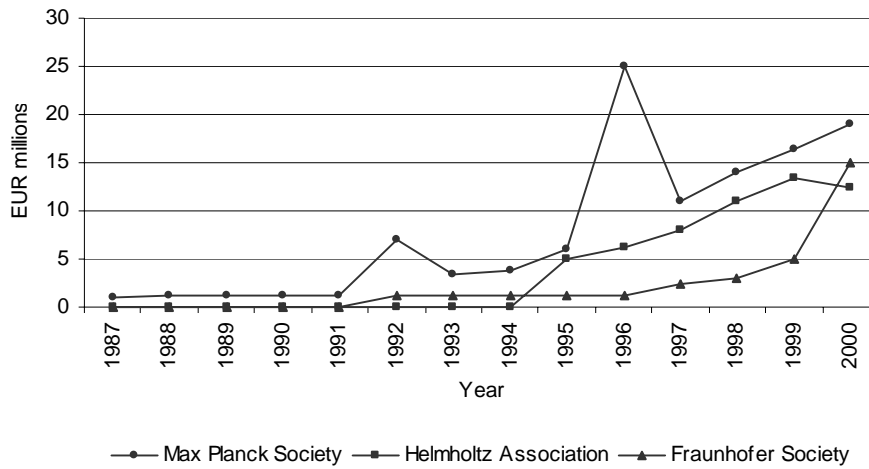
Figure 4 shows patent applications of German universities and public research organisations. The number of patent applications of the Max Planck Society is rather low. But as already mentioned, MP institutes conduct primarily basic research. In contrast, the Fraunhofer institutes are very active when it comes to patenting. This is also related to the applied research orientation. According to Gering & Schmoch (2003, p. 81), “about 40% of Fraunhofer patents are not taken with the intention of licensing; rather, they are used to support the acquisition of research contracts.”

Figure 4 Patent Applications of German PROs



Source: PATDPA (STN), WPINDEX (STN): Fraunhofer Patentstelle: Jahresbericht 2000/2001.

Figure 5 License income of German PROs



Source: Max-Planck-Gesellschaft, Jahrbuch, different years; BMBF; Fraunhofer Patentstelle: Jahresbericht 2000/2001.

## Details of the Swedish cases

### Structural characteristics of the four Swedish universities

Table 6 Structural characteristics of four Swedish universities.

	KTH	Chalmers	Linköping	Lund
Foundation	1827	1829	1975 (since 1965 technical college)	1666
Students (total)	13004	9372	18753	28708
- natural sciences	22%	-	18%	8%
- humanities/social sciences, law, theology	6%	3%	33%	56%
- technology studies	71%	97%	28%	19%
- other	-	-	21%	16%
Professors (total)	212	150	231	540
Total staff (w/o professors emeritus, student assistants and trainees)	2133	1699	2395	4647
Turnover (omslutning MSEK)	2702	2112	2345	4682

Share research/graduate education	66.8%	67.9%	49%	65.2%
External research funding MSEK	1764	1400	1141	3082
External research funding (share)	63.9%	72.9%	56.2%	55.7
- of which funded by the Swedish Research Council (Vetenskapsrådet)	14.6%	12.3%	15.7%	17.2%

Source: HSV (2003). The figures refer to 2002.

## Structural characteristics of the four Swedish TBSs

Table 7 Structural characteristics of four Swedish TBS.

	<b>Stockholm</b>	<b>Gothenburg</b>	<b>Linköping</b>	<b>Lund</b>
Established	1994	1994	1994	1994
Total investments	n.a.	90 million SEK	280 million SEK	266 million SEK
Established firms	14 firms in KTH Starthus (autumn 2003)	147	18 firms in MBI 20031231.	140
Attracted equity capital	37 million SEK (KTH Starthus autumn 2003)	926 million SEK	n.a.	n.a.
Public funding	7 million SEK (KTH Starthus autumn 2003)	59 million SEK	n.a.	n.a.
Patents/licenses	7 granted patents (KTH Starthus autumn 2003)	n.a.	4 patents are in the sales phase (Acceleratorn)	10 licenses sold (Forskarpatent)
Seed investments	n.a.	20 million SEK (2002-2003)	TBS invested in 38 start-ups	22 investments
Scholarships	n.a.	Total 11 million SEK in 140 projects with 252 individuals (jan 1997-dec 2003)	n.a.	55 a 100,000 SEK
Conditional loan fund	n.a.	n.a.	n.a.	13.5 million SEK
Budget per year	2004: 20.8 million SEK	n.a.	n.a.	n.a.

Sources: Gothenburg: data based on an effect analysis autumn 2003, Lund: data from TBS in Lund, Linköping: Segerborg (2004), homepage [www.teknikbron.org](http://www.teknikbron.org) 2004-04-14, Stockholm: data from KTH Innovation and Samverkan Nr. 1, 2003.

### Incentive structures in universities

The following elaboration about incentive structures in universities is taken from Sellenthin (2004a, forthcoming).

According to North (1990, p. 3), “institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction.” A number of different constraints exist in

universities. Patenting and commercialisation of university research involves researchers, the university and private industry and we have to have in mind that “while private enterprises are in a first approximation instructed to maximize profits, government agencies generally pursue multiple goals” (Tirole 1994, p. 1). A transfer of knowledge from university to industry means to bridge two different worlds.

Universities pursue multiple goals. Three tasks are usually mentioned in the public discussion: universities have to conduct research, educate students, and transfer research results to society in general. The goals of the university can be in conflict with each other. The time a researcher devotes to research cannot be used for teaching or commercialisation and vice versa. Thus, there are trade-offs in the daily routines of scholars between research, teaching and interaction with society in general. Traditionally, university was regarded as “an autonomous community of teachers and students, where those by devoting themselves to science would develop their individual personalities. Devotion to science implied an orientation towards research, not only for the professors but also for the students. Teaching at its best would introduce the student to doing creative research” (Keck 1993, p. 118). These ideas developed by German idealist philosophy still prevail in many universities in Europe. According to David et al (1994, p. 14), the university as an organisation possesses certain qualities. These qualities include the university community’s openness, the autonomy and freedom of individual faculty members, the receptivity accorded to novelty, and expertise. These norms have to be taken into account.

Factors that are likely to act as constraints in the internal governance structure of universities are the academic reward system including employment status, and the academic funding system.

#### *Constraints of the Academic Reward System*

The academic reward system constitutes a major factor that impacts on the incentives of academic researchers. One has to consider the motives of researchers to join the university instead of conducting research in corporate research laboratories. Dasgupta and David (1987, 1994) argue that the realms of science and technology are separated more by their social organization and reward structure than by the actual character of their work. Researchers at universities and in industry are “precommit-



ted” to different norms and rules of the game. For researchers in university, priority of discovery is the goal, and publication the means through which new knowledge is shared in timely fashion. In contrast, patents are important merits for the researcher in a corporate lab. Rewards are pecuniary and it seems that the incentive to divulge new information quickly is not as potent. Thus, publications in renowned scientific journals seem to be the means to respond to the academic reward system since publications lead to reputation and respect in the scientific community. Appointments to professorships rely mainly on scientific quality as measured by publications. Commercial success and patents are usually not regarded as scientific merits in universities in Europe. This is somewhat different in research institutes.

In relation to the reward system, employment security plays a crucial role in universities. Professors in Germany that hold a chair receive lifelong tenure and quite good pension conditions. High employment security could also mean that the scholars are independent from commercial interests. Since a tenured position is an important career goal for academics, they respond to the academic reward system to climb the career ladder. Thus, it is likely that especially younger scholars devote their time to publish research results since publications in renowned journals increase their chances to get a tenured position. Patents are usually not regarded as a measure of scientific quality in Europe.

#### *Funding*

There are also other constraints in the internal governance structure of universities that might lead to predictable behaviour when it comes to patenting and commercialisation. One important constraint is the source of funding. We can distinguish between base funding and external funding. External funding means that the decision about funding is made outside the universities via research councils, governmental departments, private industry, foreign sources etc. Within external funding there are public and private sources of research funding. Direct government funds, e.g., research contracts and earmarked funds, and grants from the EU are also included. Base funding is given in a lump-sum to the university by the State and is mainly based on past expenditure levels. According to Geuna (2001, p. 610), this type of funding was the most prevalent until the early 1980s. Geuna has shown that the share of funding from private

industry, foreign sources and foundations increased in Europe during the last two decades. There is also a general trend towards project-based research that is funded by external sources such as research foundations and research councils. One consequence is a decrease of the share of base funding.

Research funding from private industry is becoming increasingly important. As Schmoch et al (2000, p. 261) have shown, the funding expenditures of private industry doubled between 1987 and 1997 in Germany. This is in line with Mansfield's (1995, p. 61) finding that in US academia, a considerable shift from government to industry funding occurred between the 1970s and 1980s. In Sweden, direct industry funding increased from 4.8% in 1993/94 to 6.3% in 2000 (Hällsten & Sandström 2002). In countries with stagnating or decreasing base funds for university research, individual researchers have to raise funds from alternative sources. One way is to contact private enterprises and private or public funding agencies to get research funding. As Mansfield (1995, p. 62) reports, for many of the academic researchers in a US sample there was "considerable interaction between them and potential sources of funding".

Thus, in times in which base funding by public authorities stagnates or even declines, funding by private enterprises and private or public foundations and councils becomes more important. It seems also that private funding of public research becomes more important since it suggests the solution of a number of problems at the same time. Mowery and Rosenberg (1993, p. 53) claim that one of the main challenges for industry is that its competitive advantage depends increasingly on the utilization of scientific research. But increasing costs of corporate R&D make it difficult for private enterprises to maintain own R&D labs. Contract research at public universities seems to be a solution to this problem. At the same time, universities and researchers face stagnating or decreasing base funds and appreciate industry-funded research as a means to overcome financial difficulties. But "cultivation and exploitation of the potential for deriving commercial value from university-conducted research may have detrimental effects on the internal governance and external perceptions of universities" (David et al 1994, p. 15). Thus, the norms of autonomy and individual freedom as well as the norm of openness – particularly when it comes to IPRs – are threatened. Never-

theless, the new trend towards external funding acts as an important constraint that affects incentives to commercialise scientific research.

It has also to be mentioned that the chances to attract external funding depend crucially on the IPR regime since the sources of funding (e.g., private enterprises, industrial consortia) often make funding dependent on a transfer of property rights for the research results.

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