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Comparing University-Ownership Technology Transfer Systems With University-Inventor Technology Transfer Systems In Scandinavian Universities – A Question Of Focusing On Licensing Or Spin-Off Business Models?

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Abstract

Universities have become important components of the national innovation systems in innovation driven economies. To strengthen the university related flow of mainly technological knowledge into commercialized products many European countries have followed the American example and changed from an inventor-ownership system to a university-owned system (Genua & Rossi, 2011). Today most European countries have adopted a university-ownership system but with varying characteristics (Genua & Rossi, 2011). One of the strongest effects of changing to a university-owned system is a strengthening of the university support structures especially the founding or expansion of a Technology-Transfer organization (TTO). Most research indicates an increased output of patent applications, university-owned patents and license deals from the European universities (Genua & Rossi, 2011; Siegel et al, 2007). Will the university owned system give privilege to patents and license deals instead of trying to capture a higher value from university ownership in a university spinout as Kenney & Patton's (2009; 2011) research indicate?

The Scandinavian countries have since a decade changed university laws, policies and allocated specific resources in order to stimulate commercialization of university research. While Denmark and Norway changed intellectual property laws in favor of university ownership and pushed for commercialization early in the 2000's, Sweden retained the professor's privilege system or university inventor system. The paper reports on a survey of Scandinavian universities' technology-transfer offices regarding their patenting, licensing and university-spin-off activities in the years from 2000 to 2012. Results show an increase in commercialization activities in Denmark and Norway confirming earlier results by Genua and Rossi (2011). The Danish development shows a clear increase of patenting and licensing activity but a stagnation of university spin-outs. The Norwegian development is less clear but also here a pattern of more licensing and stagnation of spinouts is visible. In contrast Swedish universities' TTO-systems are organized for spinouts and produce mostly university spinouts. Patenting is done also in Sweden but primarily in conjunction with the spinout process. Moreover, pure licensing deals are rare in the Swedish system. The study provides some support for Kenney and Patton's (2009; 2011) results that university owned systems favour the business model of patenting and licensing while university inventor systems favour the business model of spinoffs. This study does however note the effect of other factors than the university intellectual property regime as important in the development. These are government initiatives and resource allocations for university commercialization, the capabilities of the TTO and the universities' choice of commercialization support structure.

Keywords

Technology transfer, University-Inventor, University-Ownership, Licensing, Spin-off, business models

1 Introduction

Universities have become important components of the national innovation systems in innovation driven economies. To strengthen the university related flow of mainly technological knowledge into commercialized products many European countries have followed the American example and changed from an inventor-ownership system to a university-owned system (Genua & Rossi, 2011). Today most European countries have adopted a university-ownership system but with varying characteristics (Genua & Rossi, 2011). While there is a widespread agreement that the university is an important part of the national innovation system there is still a considerable debate regarding what initiated the development towards a university-owned governance system as well as the consequences and effects of different governance systems (Kenney & Patton, 2009; 2011; Grimaldi et al, 2011). As for consequences and effects there is a widespread agreement that a change to a university ownership system will trigger investments in university-owned support systems (TTOs and other similar units) and, at least in the first ten years or so, an increase in university-initiated patent applications and university owned patents (Genua & Rossi, 2011, Siegel et al, 2007). But will it do so to the expense of university invented patents and company owned patents as Genua & Rossi (2011) indicate? Will the university owned system give privilege to patents and license deals instead of trying to capture a higher value from university ownership in a university spinout as Kenney & Patton's (2009; 2011) research indicate?

The Scandinavian countries (Denmark, Norway and Sweden) represent an interesting example to compare the consequences and effects of different university technology-transfer systems. The Scandinavian countries are in many ways institutionally similar with similar languages, cultures, legal systems and welfare societies. Moreover, the higher education system in the three countries are almost entirely state funded and operated and are comparable in size relative to the population. However, in the field of university technology transfer systems they have chosen different paths. Denmark has since the year 2000 and Norway since 2003 chosen to change their laws to university-owned technology-transfer systems while Sweden has retained the university-inventor system, i.e., professor's privilege. Thus, the development from year 2000 and onwards regarding university technology-transfer could be compared following the developments of these three countries.

The research questions are the following:

What are the consequences for the TTO-organizations when changing to university-owned technology-transfer system, as in Denmark and Norway, or retaining the university-inventor system, as in Sweden?

What are the effects on the TTO's business models, i.e., focus on patenting-licencing or university spin-offs, when changing to university-owned technology-transfer system, as in Denmark and Norway, or retaining the university-inventor system, as in Sweden?

Firstly, the study contributes with empirical evidence regarding strengthening and expansion of TTO-organizations in all three countries, regardless of changing governance systems. This is primarily due to a general increase in attention to university commercialization issues resulting in more resources from government and supporting legal frameworks. The TTOs have however developed in different directions. Danish TTOs have become tightly linked with the university organization and generally increased its legal capabilities, i.e., law trained personnel. Norwegian TTOs have become regional structures serving several universities with a general increase in capacity but retained dominance in business development capabilities compared to legal capabilities. Several Norwegian TTOs have also the capability to act as an investor as they have investment funds to their disposition. Swedish TTOs have also increased their capacity, but as in Norway, they have developed into a regional structure serving several universities. However, some of the larger Swedish universities also have their own TTOs. Also here the business development capabilities dominate over legal capabilities and most TTOs also have capacity to act as an investor.

Secondly, the study shows that Danish TTOs have changed their business models over time to focus on disclosure, patenting and licencing while their involvement in spin-offs have decreased. Norwegian TTOs have also increased their activities regarding disclosure, patenting and licencing but retained the level of business development and spinoffs. Swedish TTOs almost exclusively focus on business development and spin-offs.

Finally, the paper contributes towards the policy debate regarding the efficiency of university-owned and university-inventor technology-transfer systems. Similar to the debate around the Bayh-Dole Act in the US (Grimaldi et al, 2011) and the “European paradox” (Jacobsson et al, 2013) the paper asserts that the efficiency of each systems has to be determined using a wider perspective than the legal framework. This study has shown that other government incentives and systems than the legal framework affect the the organization and the outcome from the TTOs, at least in a government-financed system such as the European one. Moreover, the paper recognizes that TTOs and their universities develop their own business models, licencing and/or spin-off, and organize their resources in accordance with such a specific business model.

The rest of the paper is structured in the following way. First there will be a brief review of the literature. Second, the empirical context will be described. The third section will present the empirical data regarding the structure and output from Danish, Norwegian and Swedish TTOs. The paper ends with a concluding discussion and some policy conclusions.

2 Literature review

There is still a considerable debate regarding what initiated the development towards a university-owned governance system as well as the consequences and effects of differ-

ent governance systems (Kenney & Patton, 2009; 2011; Grimaldi et al, 2011). The Bayh-Dole act has often been heralded as the prime reason for the development of a more entrepreneurial and innovation connected university (Drucker och Goldstein 2007; Shane, 2004) while others see a more complex pattern with decreased government funding to universities, increased external funding, and scientific breakthroughs in biomedicine and computer sciences (Grimaldi et al, 2011) as well as the rise of the entrepreneurial scientist (Etzkowitz 1983; 2003). As for consequences and effects the strongest effects of changing to a university-owned system is a strengthening of the university support structures (Genua & Rossi, 2011; Siegel et al, 2007) especially the founding or expansion of a Technology-Transfer Organization (TTO). The TTO specializes in handling disclosed inventions, protecting the intellectual rights of the invention, applying for patents, licensing of intellectual rights, and assisting in spin-off processes. Most research indicates an increased output of patent applications, university-owned patents and license deals from the European universities (Genua & Rossi, 2011; Siegel et al, 2007). However, in the UK, having had a longer history of university-owned system than most other European countries, the increase in university patent activity has leveled off (Siegel et al, 2007), mimicking the development in the US.

Is a university-owned system really efficient? The researchers seem to bypass even strict university owned systems such as those in the US (Audretsch et al., 2005; Fini et al., 2010; Thursby et al., 2009). There are also some indications that the university-owned system certainly stimulate the development of more patent applications and granted patents but they tend to be of lower quality than before (Czarnitzki et al., 2008) or compared to company patents (Lissoni et al., 2010). Kenney and Patton (2009; 2011) find that a Canadian university (University of Waterloo), North America's only university with a university inventor system (professor's privilege), outperforms five similar US universities in creating spin-offs, in the fields of computer science, electrical engineering and physical sciences in the time period of 1957-2010. The result is remarkable as University of Waterloo are lower ranked in world rankings, have lower R&D-expenditures and a smaller faculty than all of the five U.S universities.

The current debates and research questions calls for more research regarding the consequences and effects of different university governance systems in different countries (Grimaldi et al, 2011; Jacobsson et al, 2013). While the overall trend in Europe have been to adopt a university owned system of technological knowledge there are considerable differences between the European university governance systems (Genua & Rossi, 2011), as well as the national economic, social and cultural systems. Thus consequences and effects may differ widely. Several countries have exemptions or dual systems in their laws.

Empirical data regarding university commercialization has been collected systematically and published annually in the US and Canada since 1991 by a survey from Association of University Technology Managers (AUTM) and used in many research projects (e.g., Siegel et al, 2007). Empirical data from European countries comparable to the AUTM-survey has not systematically been collected, but surveys from the UK and a selection

of European research institutes have been gathered and compared for the year 2004 (Arundel and Boyd, 2008) but continuous and systematic European surveys of TTO activities, structures and output are yet to be developed.

3 The legal framework and support structures of TTOs in Denmark, Norway and Sweden

All the Scandinavian countries had in their patent laws exemption to the rules of employee inventions. In Sweden the Act regarding the right to employee inventions and its university employee exemption became law in 1949, in Denmark 1955 and in Norway 1970. In Sweden the law still applies even though it has been under debate and proposals have been put forward several times for its change, most recently in a public inquiry of the system (SOU 2005:95), but the Swedish government decided not to change the law (Prop 2008/09:50) despite positive interest from most Swedish universities.

Even though Denmark and Norway have changed their laws regarding the university employee exemption all three countries share the same objective; to maximize research dissemination and commercialization from the university sector (Stenvik, 2009).

In Denmark a new law (Forskerpatentloven) was issued concerning university commercialization in 1999, in effect from year 2000, clearly regulating the intellectual rights to the universities and other higher education organizations (Stenvik, 2009). The main motivation was to strengthen the relations between industry and the universities from. The university teacher is obliged to disclose a patentable invention without delay. The university has two months to declare if it intends to take over the intellectual rights otherwise the teacher retains the rights. The university must when taking over the intellectual rights, actively work for the invention to come in use. The university will take all the costs for patent application and other types of protection. The employee has the right to receive compensation which is determined by the individual university. The most common compensation system is a 1/3 to each of the parties – the inventor, the department and the university. The system is funded by the government but complaints have been made regarding the level of funding as being very low. For the first four years of the system (2000-2004) a total of 48 MDK was allocated by the government to the build-up of the system at eight universities. In 2007 the incomes from commercialization activities broke-even with the expenses. While the development has shifted since then, the aggregated result for the five year period of 2007-2012 is a small deficit for the eight universities' TTOs. However, the system is not expected to fully cover its costs, with the exception of a few larger universities, the main aim of the new law is to increase the flow of research knowledge from universities to existing companies and for entrepreneurship.

In Norway the law of inventions was changed in 2003 and the conditions are similar to the Danish system (Stenvik, 2009). The Norwegian has a longer response time for the universities – four months. At the same time the Norwegian universities were allowed to start companies and to receive profits from these companies. The legislation in Norway

deviates in one important way from the Danish system. In Norway, the final say of publishing the research, making it available to all in the public domain, or protecting the research for commercial purposes, is vested in the researcher. Thus, a Norwegian researcher can say no to patent protection and instead publish the results without prior protection unless there are contractual restraints involving a third-party. .

Sweden as mentioned above has retained the professor's privilege even though it has been debated for more than a decade. The government decided in 2008 to not make any changes in the patent law (Prop 2008/09:50), even though the majority of the Swedish universities had expressed their wish to abolish it and transfer the intellectual rights to the universities. Today the Swedish university employee retain the exclusive right to all patentable inventions as well as other results from research and education such as software, books, templates etc (Stenvik, 2009). Thus, the Swedish researcher is free to publish his/her research, patent it, commercialize it through selling of rights, licences or services or just give it away. In the case the Swedish researcher has commercial intentions the university TTO can offer the researcher services such as assistance with intellectual protection, business advice and/or starting a company.

The Danish TTOs are small organizations. In 2004 the TTOs at the eight Danish universities had 20 employees all together. In 2012 there were 69 persons employed. Four TTOs have ten or more persons employed Danish Technical University (DTU), Copenhagen University, Aarhus University and University of South Denmark. The majority of the employees (in 2012) has a legal background and education (40 %), second most common background is medical and natural science (30 %) and some 15 % have a business and financial background (Styrelsen for forskning og Innovation, 2012).

The Danish system oriented towards furthering university employee invention includes a publically funded scheme to support business development and the assisting in the spin-off process called "Innovationsmiljöerna". These six regional organizations are not part of the university TTOs but independent of them and located at six different science parks located in various parts of the country. Innovationsmiljöerna do not only serve university spin-offs but may serve any inventor inside or outside of the universities. Innovationsmiljöerna also have investment funds which makes them able to invest smaller amounts (seed capital) in to some of the start-ups. The decision to contact Innovationsmiljöerna is however to be made by the university TTO or by the university employee if the TTO decides not to act on the disclosure.

The Norwegian system of university technology transfer includes three types of government support; financial support for business verification of research knowledge, financial support for regional TTOs' activities and financial support for infrastructure and competence development in the university technology transfer systems. There are six regional TTOs each serving several universities in the particular region and one serving applied research institutes (SINTEF). The largest are the ones serving University of Oslo (Inven2), the Norwegian Technical University in Trondheim (NTNU Technology Transfer) and University in Bergen (Bergen Teknologioverføring).

The seven regional TTOs are called “Commercialization actors” and all depend on yearly allowances from the government scheme called “FORNY”. The Norwegian TTOs tend to be somewhat larger than their Danish counterparts, the largest NTNU Technology Transfer had 22 employees in 2012 while the largest in Denmark the DTU TTO had 19 employees.

The Swedish TTOs (Innovationskontor) are located to the eight larger universities and are partly funded by a government support program. The government funding requires that the eight TTOs also take a regional responsibility serving also smaller university colleges in the region (Vinnova, 2010). Each university also have holding company which can invest into university spin-offs. Any surplus from the investment activities can be used by the TTO and university as they wish. The university holding companies have limited investment funds which often make them work with investors, private and other state investment companies. One such important state funded investor is Innovationsbron, which has the task to assist university spin-offs with business advice and also have larger investment funds which makes it able to act beyond seed capital and first rounds of investment. The eight TTOs, the university holding companies, the universities own organization for research collaborations with industry and Innovationsbron often work closely with each other, sometimes having co-located offices. The majority of the personnel working at the TTOs are working with business advice and business development. Only a few are legal experts, and often when legal expertise is needed this service is acquired from legal consultants.

4 The structure and output of TTOs in Denmark, Norway and Sweden

The availability of information concerning patent and spinoff activity at the Nordic universities varies. The Danish universities publish their information through “Styrelsen for Forskning og Innovation”, with yearly summaries of disclosure, patent applications, patents, licenses, spinoffs, personnel and so on. Data is available from 2001 until 2011. Thus the data is validated.

Denmark has eight (8) universities and their TTOs which deliver information to “Styrelsen for Forskning og Innovation”. The eight universities are; five general or Humboldtian-type universities – Copenhagen University, Aalborg University, Aarhus University, Roskilde University and University of Southern Denmark and three more specialized universities; Copenhagen Business School, IT-university in Copenhagen and Danish Technical University.

Danish TTOs	2000	01	02	03	04	05	06	07	08	09	10	11	2012
Disclosure	78	104	115	141	174	197	259	303	240	231	255	293	372

Table 1. Danish universities commercial activities from 2000 until 2012 (Styrelsen for Forskning og Innovation, 2013).

The Danish figures show very clearly the effects of a strengthening of the TTO as expenditures and personnel have increased roughly 300 % between 2004 and 2012. As noted previously the TTOs personnel is dominated by legally trained and science employees making them primarily capable of assisting in patent and licencing activities in fields where knowledge is patentable. The Danish TTOs have a limited capability to assist in spin-off processes and do not seem to work closely with other organizations having such capabilities.

[illegible]

Patents grant	-	-	-	-	-	-	-	-	-	-	-	-	-
Licence deals	7	9	5	3	1	5	21	24	38	31	34	34	58
Licence portf	32	41	46	49	50	55	76	100	138	169	203	237	295
Spinoffs	26	37	34	23	20	37	27	32	33	36	19	26	22
Spinoff portf	26	63	97	120	140	177	204	236	269	305	324	350	372
Income Mnkr	-	-	-	-	-	-	-	-	-	-	-	-	-
Exp'd Mnkr	-	-	-	-	-	-	-	-	-	-	-	-	-
Employees	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2. Norwegian universities commercial activities from 2000 until 2012 (NIFU, 2013; Forny, 2012).

As you can see in table 2 disclosure figures have only been published the last two years (since the FORNY2020-programme started) and then also aggregated figures for licence deals and spinouts from 2000-2012. The figures indicate rising license activities over time and stagnating spinout activity over time.

In Sweden data is very hard to gather. Moreover, the definitions vary and it is not self evident which unit is the TTO-unit. Thus, there is now overall statistics gathered by anyone. Since 2011 most Swedish universities publish figures regarding disclosures, patents and spinoffs as it is required by their owner, the Swedish state. Thus it is hard to come by statistics before 2010.

Swedish TTO-units are usually a mix of a traditional TTO-office, an incubator and an investment company owned by the university. This is the case at the seven largest universities in Sweden. The reason that Swedish TTO-units are a mix of these three components is the government programs that have been launched in the period of 2000-2012. The Swedish government funds innovation offices at these seven universities, if it also serves other higher education institutes in the region. It also funds an incubator if it collaborates with the innovation office and serves the other universities in the region. Lastly, it has given money to seven larger university holding companies which usually works closely with the innovation office and the incubator. Even though the holding companies have a limited capital to invest, they still make universities able to take smaller stakes in spin-offs and act as an investor. Thus, a Swedish TTO-unit, at the larger universities is a more complex and has more functions (business advice, business development, IPR, incubation, and financing) than their Norwegian and Danish counterparts. Their personnel is dominated mostly by business advisors, while legal expertise represents a minority, often external legal consultants are hired to complement the internal expertise.

Swedish TTOs	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Disclosure	-	-	-	-	-	-	-	-	-	396	473	476	562
Patent appl	-	-	-	-	-	-	-	-	-	-	132	115	126
Patents grant	-	-	-	-	-	-	-	-	-	-	-	-	-
License deals	-	-	-	-	-	-	-	-	-	-	-	-	-
Spinoffs	-	-	-	-	-	-	-	-	-	35	45	59	56
Spinoff portf	-	-	-	-	-	-	-	-	-	-	-	-	-
Income Mnkr	-	-	-	-	-	-	-	-	-	-	-	-	-
Exp'd Mnkr	-	-	-	-	-	-	-	-	-	-	-	-	-
Employees	-	-	-	-	-	-	-	-	-	68	71	115	106

Table 3. Six Swedish universities commercial activities from 2009 until 2012 (Lund University, KTH, Chalmers Technical University, Linköping University, Gothenburg University, Uppsala University, annual reports and university holding companies annual reports for 2009-2012).

Holding in mind that data from the six universities and their holding companies are not validated by any independent organization (compared to Danish and Norwegian figures) and the short time series we can see increases in activities, both in disclosures and in spin-offs. Unfortunately licence delas are not reported but pure license deals seem very uncommon. The Swedish TTOs are also larger than the Danish TTOs, and more like the Norwegian TTOs. Being investment companies, although poorly capitalized, they also have the possibility to invest in start-ups. The Swedish TTOs also run several other university-related services (incubator and investment company) which make them larger in size than the Danish TTOs, and again more like the Norwegian TTOs.

5 Concluding discussion

First I discuss the results in relation to the research questions.

1) What are the consequences for the TTO-organizations when changing to university-owned technology-transfer system, as in Denmark and Norway, or retaining the university-inventor system, as in Sweden?

The TTO organizations in all three countries have expanded regardless of changing governance systems. This is primarily due to a general increase in attention to university commercialization issues resulting in more resources from government and supporting legal frameworks. The TTOs have however developed in different directions. Danish TTOs have become tightly linked with the university organization and generally increased its legal capabilities, i.e., law trained personnel. Their capacity to act as business developer and to assist in spin-off processes has not increased after changing the law. Instead the business development capacity has been located to other organizations located at regional science parks. These organizations have a broader mission serving all

technology-based entrepreneurship not only academic entrepreneurship. Norwegian TTOs have become regional structures serving several universities with a general increase in capacity but retained dominance in business development capabilities compared to legal capabilities. The government support for the Norwegian TTOs has increased in later years making them able to increase their services towards academic entrepreneurs. Several Norwegian TTOs have also the capability to act as an investor as they have investment funds to their disposition. Swedish TTOs have also increased their capacity, but as in Norway, they have developed into a regional structure serving several universities. However, the TTOs are located to seven of the larger Swedish universities which in practice means that mainly serve these seven universities. Also here the business development capabilities dominate over legal capabilities and most TTOs also have capacity to act as an investor as they collaborate closely with the universities' holding companies located at the same seven universities.

2) What are the effects on the TTO's business models, i.e., focus on patenting-licencing or university spin-offs, when changing to university-owned technology-transfer system, as in Denmark and Norway, or retaining the university-inventor system, as in Sweden?

In Denmark there has been a pronounced increase in patent and license activity, and decreasing level of spin-off activity, since the university-owned system was introduced in the year 2000. The focus at Danish TTOs is strongly towards licencing and research collaboration. The Danish TTOs are rather small organizations, usually around 10 employees, and the majority of the personnel have legal training and education. The capacity to assist in spin-off processes is located to other organizations not co-located with the TTO, thus these organizations seem do not seem to work tightly together. In Norway there is also an increase in patenting and licencing but less pronounced than in Denmark. The reason for this is the strong government support in Norway for increasing the business development competence at TTOs and several programs for assisting start-ups with seed financing and other types of support. Thus, the Norwegian TTO sees their job also to assist researchers to these government support schemes. In Sweden the TTOs main role is to assist in spin-off processes. The Swedish government support programs are oriented towards building business development capabilities and investment capabilities in the TTOs are closely related organizations. While the Swedish is able to assist in IPR-issues the main aim is not patent and licence, the main aim is to patent and hold in the spin-offs.

In conclusion, this study provides some support for the effect of a strengthening of the TTO organization in relation to a change from a university-inventor to university ownership system (Genua & Rossi, 2011; Siegel et al, 2007) as seen in the Danish and Norwegian case. The Swedish case, with an expanding TTO-organization, due to strengthening of other legal frameworks, e.g., universities being able to invest in spin-offs, and financial support from the government, shows that it is not only the IPR-law that may cause this effect.

Moreover, this study provides some support for Kenney and Patton's (2009; 2011) result that university-owned systems favors patent and licenses while university-inventor systems favors spinouts. The study reported here does however note the effect of other factors than the university intellectual property regime as important in the development. These are other government initiatives and resource allocations for university commercialization and the universities' choice of commercialization support structure and business model.

While the choice of governance system for university technology-transfer is an important one, it is not the only factor that will determine the size, development and business model of the university TTO (cf. Grimaldi et al, 2011). In a European context other legal frameworks concerning university third mission activities and government support schemes will also affect the TTOs as will the existing network of collaborations with industry.

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