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Academic Entrepreneurship[1]

Social norms, university culture and policies

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Abstract

Is a shift in intellectual property rights to universities the key instrument in increasing commercialization of publicly funded research? How much can actually be learned from the U.S. system, disregarding the ongoing debate as to whether the U.S. do actually outperform Europe in terms of commercializing university based research? Taking Sweden as a role model I claim that this policy will not work. This allegation stems from the analysis of a unique database giving individual university researchers view on participation in commercialization of public research, their commercialization experiences, and the obstacles researchers claim exist to increase academic entrepreneurship. Despite researchers positive attitudes towards engaging in commercial activities, the university culture, weak incentive structures and badly managed support facilities impede the creation of efficient links to markets. I conclude that measures must be taken at primarily the national level, but also at the university level, to enhance commercialization activities.

Keywords: Academic entrepreneurship, commercialization, links, policies.
JEL: J24; O31; O57

”….the production of inventions and much other technological knowledge, whether routinized or not, when considered from the standpoint of both the objectives and the motives which impel men to produce them, is in most instances as much an economic activity as is the production of bread.” (Schmookler 1966)

1. Introduction

The American way of transferring academic knowledge to the market has been claimed to outperform Europe's (Rosenberg and Nelson 1994, Link 1996, Caloghirou et al. 2001). Presently this is a topical issue in Europe where most countries have abandoned the traditional open science model in favor of a system where universities can appropriate and patent findings that stem from publicly financed research. The role model as regards intellectual property rights (IPRs) has been the Bayh-Dole Act, implemented in the U.S. 1980.

Opinions do however differ as regards the efficiency of introducing a U.S. based system.[3] The lack of data on the extent of commercial spillovers emanating in public research, makes it extremely difficult to assess the efficiency of the European and the U.S. systems, respectively. The U.S. position over the last decades as the world's most prominent supplier of scientific articles, patents and – in particular – novel, high-technology firms and the emergence of new industries do however indicate that the links between R&D and its commercial applications are superior as compared to Europe.

Still, shifting the ownership of IPRs to universities has in most European countries been considered as a key instrument to engage universities in the so-called "third mission". That is, in addition to education and research tasks, universities shall also interact with society, taking an active part in the diffusion of knowledge to other sectors. Universities have thus been given considerable responsibility for an increased interaction with private business and assigned a more active role in the commercialization process. This new role implies developing new functions and structures within and around the universities (Feller 1990, Miner et al. 2001).

Why is this an important issue? According to the current growth paradigm, knowledge (often measured in terms of R&D) is claimed to be the key in fostering economic growth and societal prosperity. One obvious channel to convert university-based research into commercial

applications is through academic entrepreneurship. Previous research has convincingly shown how entrepreneurs and small firms, even if they do not invest large resources in R&D themselves, contribute to the diffusion and commercialization of research (Acs and Audretsch 1988, Baldwin and Johnson 1994, Jovanovic 2001). In this way, entrepreneurs and small firms are considered to have a positive impact on growth in the American economy. A vibrant and innovative small firm sector seems however to be a missing component in many European countries as compared to the U.S. (Henrekson and Rosenberg 2000, Rosenberg and Hagén 2003, Etskowitz et al. 2005, OECD 2007).[4]

By examining a detailed dataset on Swedish researchers affiliated with one of the established – but still relatively young – universities (Linköping University), this paper aims at shedding light on researchers attitudes towards engagement in commercial activities, the degree of commercialization that has taken place among researchers, and the extent to which the university has provided adequate support in that process. In that context I will also discuss the distributions of responsibilities between the "policy-maker" (the government) and the universities, and the need of these to complement each other in order to enhance the commercialization process. Based on the findings there will also be an assessment whether academic entrepreneurship may constitute a weak link that influences the entire Swedish innovation system, and to what extent the adoption of a Bayh-Dole system is likely to improve knowledge flows between universities and the commercial sector.[5]

The rest of this paper is organized in the following way. First some stylized facts related to academic entrepreneurship in Sweden are presented, followed by a brief survey of previous research that is of relevance for the issues raised here (section 2). The data – and how they are classified on different groups - is presented in section 3 together, while attitudes of academic researchers and their experience of on engaging in commercialization processes is discussed in section 4. The following section 5 reveals the support that researchers consider

themselves to need and the measures that Linköping University has taken in order to facilitate and reinforce the commercialization of research. Finally, measures to alleviate the weaknesses in the links between research at the universities and private business are discussed (section 6), while section 7 concludes.

2. Academic entrepreneurship: Some stylized facts and previous research

Academic entrepreneurship is one channel – that co-exists with other channels such as licensing, contract research, "pure" knowledge spillovers, labor mobility, etc. - to transform university research into goods and services. The societal interest is related to the potential welfare gains that academic entrepreneurship may induce through increased consumer utility (new products or improved varieties of existing products) and augmented future prospects for higher growth rates. The latter effect is due to new knowledge being dispersed to private business, which can be expected to bolster productivity, introduce new products and processes, often in high value-added activities. From a theoretical angle, academic entrepreneurship is linked to the realm of knowledge based (endogenous) growth theory, particularly the neo-Schumpeterian approach (Schmitz 1989, Romer 1986, 1990,1994, Aghion and Howitt, 1992, 1998, Acs et al, 2005).

Academic entrepreneurship in Sweden

Sweden stands out as a particularly interesting European example. For a long period of time Sweden has been one of the world's largest investor in research and development (R&D) in relation to GDP.[6] Moreover, Sweden has had a leading position when it comes both to patents and the number of scientific publications per capita. This should constitute an excellent breeding-ground for entrepreneurial led growth, characterized by entry of high-technology start-ups

and market experimentation. However, for most of the time since 1970 Swedish growth has not matched average growth in the OECD-countries (Lindbeck 1997, OECD 2007), with the exception of the last decade. Albeit this successful period seems to be explained primarily by a "catch-up" effect after the Swedish crises in the early 1990s, a strong export performance due to a depreciating krona, and a favorable specialization in high-productivity industries, and not primarily by knowledge driven growth (Braunerhjelm 2005).[7]

This has sparked a discussion about a "Swedish paradox", that is, despite Sweden's high R&D-investments specialization still is concentrated in low- and medium technological production (Braunerhjelm 1998, 2007, Edquist and McKelvey 1998).[8] Ejermo and Kander (2006) have questioned the existence of such a paradox. They also stress that the link between R&D-expenditures and entrepreneurship is not that self-evident. Even though R&D is likely to render inventions, the link between inventions and innovations hinges on a number of other and complementary inputs. In addition, Ejermo and Kander draw attention to the fact that R&D expenditures are strongly concentrated to a few Swedish firms, which to a large extent is exploited in their foreign affiliates. They also provide a useful framework to illustrate the different step that links R&D with high technology and GDP-effects, and those universities are primarily involved with inventions.

Even though the description by Ejermo and Kander is basically correct, the question remains why externalities and spillover seems quite limited in the Swedish context. As evident from previous research on Swedish data, the success of spin-offs from Swedish universities has been limited. Olofsson and Wahlbin (1993), using a sample of 569 technology-based firms for the period 1974–89, found that at the beginning of the 1990's, very few firms had a turnover exceeding 250,000 US$. Rickne and Jacobsson (1996) also show the employment effects of new technology-based firms established in the period 1975–93 and still active in 1993 to be marginal. Moreover, none of the firms had grown sufficiently to employ 500 peo-

ple or more. Lindholm Dahlstrand (1997) concludes that firms stemming from universities grow more slowly than other firms.[9] At the same time, a large number of science parks have been created in the last few decades. In 1997, there were 17 such parks connected to Swedish universities, employing about 10,000 people (Lindholm Dahlstrand 1998).

More contemporary studies corroborate these previous results (Goldfarb and Henrekson 2003). The general picture is that the extent of academic entrepreneurship remains fairly low. A study by Nås et al. (2003, 2004) reveals that despite considerably larger Swedish R&D outlays, the weighted share of high-tech start-up in Sweden is lower then in Denmark and Finland, albeit considerably stronger then Norway: the share of high-technology start-ups is one percentage point above the average for the four countries in Sweden, which compares with almost six percent for Finland and 17 percent for Denmark, while Norway is almost 20 percent below the average (see the appendix).[10] The overall researcher participation in new firms is also lower in Sweden in high-tech manufacturing and in knowledge intensive services is also lower as compared to Denmark and Finland. Delmar et al. (2003) conclude that there has been only a slight decrease in the numbers of high technology self-employed between 1990 and 2000. It is notable that this decline in the high-technology sectors coincides with an overall increase – i.e. taking all sectors into account – in self-employment in the range of four percentage points over this period.[11] Accordingly, there may be a potential to enhance academic entrepreneurship in the Swedish innovation systems.

Previous research: A selected survey

The traditional European link between research and its commercial applications has primarily been through the "open science model", i.e. externalities created by public research at universities.[12] As evidence has piled up as regarding the potentially important impact of public re-

search on innovations, the role of universities has partly been redefined in the 1990s, especially in Europe. Gunasekara (2006) provides a literature survey on the impact of universities on regional innovations systems, concluding that the role of universities has increased in the latter decades.[13] Universities are claimed to purport a multifaceted role that tend to strengthen regional agglomeration, including human capital provision, dissemination of knowledge, entrepreneurial activities, and they also serve to attract firms. In addition, university-industry linkages tend to nurture a collaboration culture, which strengthen regional development. Hence, there seems to be a rationale as to why universities should carry out a more active role in the transformation of academic knowledge into economic knowledge. Still, success in that respect hinges on a number of other factors as well.

To start with, there is an extensive literature showing that commercialization of new knowledge and research requires an environment that allows exploitation of new findings within new ventures (Feldman 1999, Acs and Audretsch 2003, Shane 2003).[14] In addition, more extensive interfaces with the commercial sector are likely to require a new set of routines and norms. Altering existing routines and norms that has prevailed since long is a difficult and time-consuming task (Hannan and Freeman 1984, Nelson and Winter 1982, Cooke 2002, Gunasekara 2006).

Individuals tend to be shaped by the economic and social context in which they have been trained and currently are active in. The degree of such social imprinting, the intellectual openness and learning capabilities, together with the incentive structure that faces researchers, determine the potential for benign attitudes towards commercialization to be established (Berkovitz and Feldman 2004). Owen-Smith and Powell (2001, 2006) have shown that crucial factors in adopting norms more positively inclined towards commercialization is associated with the awareness of potential success and benefits of closer interactions with private business, to what extent peer environment embrace such changes, and the academic prestige of

commercialization. If those factors work to encourage increased interaction with commercial sectors, Owen-Smith and Powell conclude that the chances of a smooth transformation towards a new norm is considerably augmented and could well positively influence both basic and applied research. This seems to suggest that proper mechanisms and economic incentives designed to foster an increased interaction between universities and firms is a necessary but not sufficient condition: attitudes and norms at the universities must complement such institutional prerequisites in order to enhance the diffusion of knowledge to other parts of the society.[15]

The efficiency of different types of IPR systems in order to foster commercialization has also been increasingly questioned. Notwithstanding that several studies confer that European universities seem to be involved in commercialization – measured as the number of patents – to a much lower degree then in Canada or the U.S., others provide evidence that the extent of the commercialization effects of European public research is underestimated.[16] In a study on Belgium, Finland, France, Germany and Italy, Balconi et al. (2004) claims that university initiated patents (although nor owned by the universities) are considerably higher then previously reported. Similar results are reported Meyer (2003), Saragossi et al. (2003), and Azagra and Llerena (2003). Moreover, there are also results indicating that the degree of technology transfers is hampered by a system where the universities can appropriate the research findings (Rod 2006, Litan et al. 2007).

Arundel and Bordoy (2006) extend the argument to the discussion to involve the so called “European paradox”, i.e. that Europe invest quite heavily in R&D but get little leverage out of it in terms of innovative activities, new firms and increased employment. By comparing six different surveys related to R&D and innovative activities, they refute the idea of Europe lagging behind the U.S., with the exception of patent granted. Rather, depending on which variables are used, the evidence are mixed. Dosi et al. (2005) end up in the same conclusion,

i.e. the European paradox is basically a myth, but from a different perspective. They show quite convincingly that Europe is not leading in research – irrespective of whether citations, publications, research funding, or other criteria are used. Hence, if Europe does not have an edge in research as compared to the U.S. (or Japan), there is no reason to expect a superior performance as regards high-technology industries or start-ups. According to the authors, Europe suffers from the opposite problems: underinvestment in research, weak corporate sector in leading industries, weak research environment in the most technologically advanced industries (pharmaceutical and ICT). Hence, policies have to be reconsidered and shifted from "networking" strategies and establishing commercial link, towards creating more sophisticated research environments and a more competitive corporate sector.

Thus, there is an ongoing debate as too whether the institutional change in the U.S. (the Bayh-Dole act) actually prompted the increase in university patenting, or whether that was already taken place, primarily due to substantial increases in research and funding – especially in biotechnology - in the late 1970s and the beginning of the 1980s. Surveying this strand of the literature, Geuna and Nesta (2004) conclude that there is no evidence of university patenting being an efficient device to transfer technologies and know-how to the commercial sector. It is also well documented that the majority of U.S. universities do not generate positive net income from technology transfers.[17]

3. The database

Based on individual data – described below – I will illustrate the prerequisites, and possible obstacles, to academic entrepreneurship. All data used in the analysis concern one of the largest Swedish universities (Linköping University). The University is relatively young (founded in 1969), has about 20 000 students, a strong technological edge, as well as an adjacent science park. The data were gathered in a survey undertaken by the Swedish National Audit Of-

fice (RRV) in the period January–March 2001 and later on used in a more general evaluation of Swedish universities. More recently the data has been available for researchers. The questionnaire consisted of a number of predominantly closed question, internet-based, and targeted all researchers at the Institute of Technology and the Faculty of Health Sciences at Linköping University.[18] The response rate was just below 30 percent and about 58 percent of the answers were provided by professors while other researchers (associate and assistant professors, etc.) accounted for the remaining part.[19]

The researchers have been classified on five different sub-categories, some of them quite small as appears from Table 1. For example, the subgroups belonging to the categories "commercialized in corporations where the researcher is the sole owner or has a proprietary interest" together with researchers "who intend to commercialize", only consists of 13 and 19 respondents, respectively.

Table 1

According to Table 1 about 40 percent of the researchers report that commercializing is not an issue, for various reasons, while the rest consider that their research has or will have commercial potential. Note that only 17 percent of the researchers have commercialized their research results, whereof six percent in firms where they have an ownership stake. Somewhat more than a third state that their research has not been commercialized, despite its being considered to have commercial potential.[20] Overall, the figures reveal – according to the respondents – that there is a large unexploited stock of research or ongoing research that has not been included in the commercialization process.[21]

It is in that perspective that well-developed links between universities and private business can be expected to be decisive in order to expose academic research to potential entrepreneurs and "market experiments". Only a fraction of these market experiments will lead to new and growing firms, hence, a successful introduction of new services or goods requires

large gross entry flows of firms. It might be argued that a large amount of such market experiments is what characterizes a dynamic and innovative economy.

4. Researchers attitudes and experience of commercialization

According to the findings reported by RRV (2001), there is basically a strong support for cooperation between Linköping University and private business. An overwhelming majority (84 percent) of the researchers at Linköping University agree completely or partly with the view that it should be part of the responsibility of the university to encourage the commercialization of research results. Yet, a large share (77 percent) considers that they are in need of more information on how to interact with private business.[22] How such cooperation should be organized is less clear-cut, however. Among the interviewees, 51 percent stress that too much emphasis on cooperation with external agents might constitute a threat to independent research. About the same number (54 percent) considers an increasing part of research that is financed by private agents to be negative. The attitudes as regards the university as a conduit for facilitating and intervening in commercialization are thus basically positive, but not uncritical.[23]

When it comes to implementing concrete measures, 75 percent of the researchers are positive to the university supporting technology-based start-ups by providing business incubator services. Almost three researchers out of four want the graduate program to convey knowledge of how research can be commercialized, particularly younger researchers are very positive to this. Interestingly enough, about 50 percent of the Swedish researchers also think that patents should be valued as highly as scientific publications. However, there seems to be more skepticism towards the role of the university as an investor in seed capital, where researchers have more trust in private agents.

Judging from previous studies on the U.S., American researchers seem to be more market-oriented than Swedish ones; in the U.S. researchers find it more important that support and capital come from the private market. The differences are particularly large when it comes to support for business incubators, seed capital, the evaluation of patents, and research directly financed by private firms.[24] Obviously the existence of such different views, which could reflect different traditions and cultures, might constitute an important explanation to the differences in the degrees and the outcome of academic entrepreneurship.

In contrast to the U.S., the proprietary rights to new inventions are owned by the researchers in Sweden, which may affect the relations between researchers, universities and private business. From the data in the questionnaire, it appears that about half of the researchers consider that less research results would be commercialized if the present structure were abolished. However, a large number of researchers do not express a view on this issue.[25]

In order to get a further grip on the commercialization process and the links between the university and private business, researchers' experience in these areas is presented. The first issue concerns what support the researchers in Linköping consider themselves to be needed, and what kind of support that is available. Of particular interest are the following categories: those who have carried out a commercialization, those intending to do this, and researchers who consider their research to have commercial potential but who have not proceeded in this area.[26] Note that the answers concern support in general, irrespective if it is external or comes from university-based organizations.

Researchers having commercialized their research

As was shown in Table 1, commercialization of research has predominantly taken place in corporations where the researcher has no owner stake (68 percent of those who have commercialized). The remaining 32 percent have chosen to establish their own firms. Naturally, these

two kinds of commercialization entail different amounts of involvement from the researchers, which are also reflected in the need for support they experience (Table 2). Note that this sub-sample accounts for about 17 percent of the total sample (40 researchers), i.e., it is a relatively small group.

Table 2

It is not surprising that wide differences appear between these two groups. A relatively large share (almost 60 percent) of the researchers who chose to commercialize their research in a corporation where they had no ownership did not feel that they needed any support. On the other hand, 92 percent of those researchers who instead chose to commercialize their research through a firm of their own reported that they were in need of some kind of support, whereof 42 percent considered it to be difficult or fairly difficult to obtain the required support. A similar proportion (42 percent) found it simple, or fairly simple, to obtain support. The need for support is claimed to be largest for market analysis, marketing, initial capital and management competency. Many also need help with premises and administration.

Existing potential but no commercialization

The group of researchers that consider their research to have a non-realized commercial potential is the largest of the groups studied more closely (36 percent of the sample). Unfortunately, there is no information on insufficiencies in specific needs for support, but the motives for the absence of commercialization are presented in Table 3.

Table 3

Lack of time is the predominant reason (61 percent) why researchers have refrained from trying to commercialize their results. An implicit priority given to other areas than commercialization can also be assumed to affect this high percentage share. The 13 percent who have not yet made sufficient progress with their research to determine whether they will

try to realize the stated commercialization potential, and also those who have stated "Other reason" – which includes insufficient interest in entrepreneurship and a strong desire to teach – for non-participation in the commercialization process, constitute the second largest alternatives among the replies.

Factors contributing to research not being commercialized although the respondent has not stated lack of time or non-interest in commercializing, can mainly be attributed to the alternatives "Due to the views on commercialization….", "Since I have insufficient knowledge …" and to a certain extent the alternative mentioned above, "Other reason". Altogether, this corresponds to about 10–15 percent of the respondents in this group of researchers. This might seem a modest share, but the size of this group – 36 percent of the sample – means that there is a non-negligible potential to involve these researchers in the commercialization process.

Researchers who intend to commercialize their research

This group of researchers is of particular interest, in the sense that they distinguish themselves by clearly wanting to commercialize their research results, but do not consider themselves to have sufficient knowledge. This is the smallest group – 8 percent of the sample – among the three categories studied and the results are summarized below but not depicted in a table.

When these researchers can choose between establishing their own firms and letting someone else take care of the commercialization, the majority claims to prefer the latter alternative. Researchers in this group consider themselves in need of considerable support in a wide range of areas (applications for patents, licensing, market analysis/marketing plan, initial capital, marketing, premises/administrative support and contacts with firms/mediation) in order to carry out the commercialization. A surprisingly high share (almost 50 percent) of the researchers does not know where to turn in order to get the support they consider themselves

to need. The data from the questionnaire also show that those researchers who know where to turn for assistance are much more positive to commercializing through a firm of their own.

To summarize, knowledge about commercialization is scarce and there is substantial need for support. Note also that an extensive share (61 percent) report lack of time as the main impediment to engage in commercial activities. Even though this share is likely to also capture other individual motives, as well as academic sentiments towards commercialization, it also underlines the importance of efficient support to facilitate for the commercialization of academic research.

5. University measures to facilitate commercialization

One issue explored above concerns how the support the researchers have obtained corresponds to their reported needs. The question is what actions Linköping University has taken to improve the commercialization process. At present, there are two main channels for facilitating and improving the links between private business and the commercialization of research: Universitetsholding (the holding company of the university) and Centre for Innovation and Entrepreneurship (CIE).

Universitetsholding has existed since 1993 and was established at the initiative of the Ministry for Industry, Employment and Communications. Its initial endowment was approximately 700,000 U.S.$ and there has been no additional government funding. Through a cooperation agreement with another government funded regional agent (Teknikbrostiftelsen) in Linköping, the holding company has obtained a conditional loan amounting to 1.75 million U.S.$; a capital which must not be used for seed financing, however. Hence, Universitetsholding should not be considered as a holding company in practice, but rather as a supporting function at the initial stage of the commercialization process. The university holding company is, for instance, not allowed to accept capital from private investors.

Universitetsholding's view of the commercialization process is that it should be the first authority to contact for researchers who want to test whether their ideas have a market potential. Universitetsholding then provides initial advice and possibly financing on a small scale. On average two ideas a week are presented to Universitetsholding, often at an early and preliminary stage, and most of these are turned down. In those cases with commercial potential, some form of establishment within the adjacent science park (Mjärdevi) is often the next step. Universitetsholding also deals with applications for patents and scrutinizing new ideas, as well as carrying out pure informational activities. Its activities are not limited to researchers only, but encompass all employees and students.[27]

CIE was established in 1993 and is today a center at the Department of Management and Economics at Linköping University. The entrepreneurial education program (ENP) is the part of CIE's educational program of most interest here, since one of it aims is to solve the problems that emerge when university employees plan to establish a new firm. The program, which is entirely free of charge and has been offered since 1994, targets researchers and students, but is also open to employees in already existing firms. It is based on a number of workshops on topics relevant to an entrepreneur, e.g., private business development, management, marketing, sales and financing. Each participant also gets access to a mentor to create a link to the business sector. After completing the program, participants can get further assistance, for example through favorable office premises in Mjärdevi science park.

The actual importance of the entrepreneurship program at CIE for the commercialization of research results is indicated by the number of researchers actually completing the program. Altogether, 244 people have participated in the program during the period 1994 to 2001, 66 of whom were researchers (including graduate students) connected to Linköping University (Table 4).

Table 4

Since 1999, 33 researchers have completed the ENP-program, which corresponds to 20 percent of the participants. An overwhelming majority of the researchers who have participated in the program comes from four departments at the Institute of Technology or from the Faculty of Health Sciences, Linköping University. Still, this should be compared to the 2,724 researchers that are active at Linköping University, 1,396 of whom are graduate students (Linköping University 2001), implying that only a fraction (1,2 percent) of researchers take the ENP-program (Linköping University 2001).

Researchers' view of Universitetsholding and CIE

How do the University's central supporting functions for facilitating the commercialization process work, according to the researchers? Looking at the three first categories mentioned in Table 1, a picture emerges where researchers either do not know about the university-based organizations or their support is considered to be without interest. As concerns the first two groups, only 10 percent consider that the holding company works well, while more than 80 percent of the researchers either do not know what the holding company does or consider that it has not succeeded in explaining what support it offers (Figure 1).

Figure 1

For the group of researchers with the intention of commercializing their research results but who have not yet done so, 61 percent have no knowledge of the support offered by Universitetsholding (Table 5). Moreover, it is remarkable that more than half of the researchers who know about the activities of Universitetsholding are not interested in the support it offers (22 out of 39 percent). In other words, despite the fact that university supporting functions have existed for about 10 years, knowledge about their role seems either to be very limited among researchers, or not wanted.

Table 5

6. Academic entrepreneurship – the weak link in the innovation systems?

Three main factors emerge that may hamper commercialization of university research at Linköping University. First of all, the share of entrepreneurial activities (established new firms) by researcher amounts to six percent, considerably lower then general propensity to become self-employed. Note that this picture emerges despite researchers having a positive view of commercialization and cooperation with private business. Two thirds of the research results that were commercialized reached the market through firms where the researcher had no proprietary interest. A similar share (72 percent) among those researchers intending to commercialize their research results wants other firms to handle the commercial process. The low interest in entrepreneurship is not exogenous, however; it originates in various conditions inside and outside the university, i.e. the environment of the potential entrepreneur.

Second, it is of interest to note that two thirds of those researchers who have already commercialized, as well as those intending to commercialize, do generally not find cooperating with firms to be sufficiently profitable.[28] The fact that researchers to a large extent still do not choose to commercialize in companies of their own is an indication of entrepreneurship being considered to be an even more unfavorable alternative. Conceivable reasons for the propensity to engage in new ventures and entrepreneurial activities are also related to institutional conditions (laws, regulations and taxes), i.e., an area where the responsibility can be found at the level of national policy-makers.

Third, the researchers' need for support during the commercialization process provides a picture of the individual qualifications for entrepreneurship, and the need for being in an environment that can provide those facilities. Here, the insufficiencies can be traced to the way the university handles information as well as more active measures for support. The support researchers state they need in order to establish a firm compares quite well to the ENP-program of CIE. What might be questioned is whether the scope of the program is sufficient

to create the desired interest and motivation for researchers to become involved in entrepreneurial activities. More resources may be required to develop CIE's ENP-program into a better tool for promoting entrepreneurship among researchers who are today hesitant to running their own business. The fact that researchers constitute a negligible part of the total number of participants in the ENP-program is likely to mirror a combination of a generally low entrepreneurial level among researchers, insufficient resources at CIE for marketing its educational programs, and a culture which is nor conducive for academic entrepreneurship.

As concerns those researchers having already commercialized their research – "commercialized in corporations where the researcher is the sole owner or has a proprietary interest" and "commercialized in corporations where the researcher has no proprietary interest" – it turns out that in 75 percent of those cases where researchers chose to commercialize in a firm of their own, they obtained the support they considered themselves to need, without extreme difficulties (see Table 2). This mainly occurred outside the various university systems, however. Moreover, about 90 percent had no knowledge of the activities of Universitetsholding and CIE (Figure 1).

At the same time, these groups report being in need of more support and information as concerns competency in management and marketing. Marketing is often a very intensive and resource-demanding activity, where agents like Universitetsholding and CIE might provide guidance or education. Here, closer – and more varied – links to market-oriented agents, such as risk capitalists, business angels and established firms, are essential ingredients for creating the necessary and market-based contacts.

Those researchers with the intention of commercializing considered themselves to need massive support in practically all areas, from patents and licensing to premises and contacts with private business. Still, they show a strong interest in commercialization in general. What is remarkable about this group is the large number of researchers who do not know

where to turn to obtain the support they need. Considering that Universitetsholding and CIE should be able to assist these researchers in many of their problems, this stepping-stone to increased entrepreneurship should not be an insurmountable obstacle. Hence, there should be large potential for increased commercialization, provided that the right agents are connected to each other and that researchers obtain the required support. As shown above, those already knowing where to turn for support also turn out to be considerably more inclined to commercialize in a firm of their own.

7. Conclusion

Differences in attitudes towards entrepreneurship and commercialization across countries and regions have been formed through culture, economic incentives and traditions which feeds back into social norms that captures the value and desirability to start new ventures and become an entrepreneur. Sweden, rooted in the European welfare state tradition, can be expected to illuminate European attitudes towards commercial activities that originate in university R&D.

What conclusions can thus be drawn from the unique Swedish database implemented in the analysis? A first observation – perhaps somewhat unexpected – is that individual researchers themselves are positive to commercializing their results, a large share even state that they are willing to devote more time to this purpose. These attitudes are similar to those found for U.S. universities. Support functions have also been established by Linköping University in order to facilitate commercialization, but researchers consider these to be insufficient.

A crucial issue concerns the researchers' links with market-based agents. It has previously been shown that centralized organizations for external contacts do not work well in the commercialization process, even though they can fulfill complementary tasks (Etskowitz et al,

2000).[29] A study by Meyer-Krahmer and Schmoch (1998) suggests that collaborative research and informal contacts between universities and the industry are the most effective channels for transfers of knowledge, and that there is a two-way flow; the industry also provides knowledge used in university research. The conclusion is that the support functions at the university must become more professional and market oriented. This study corroborates previous findings.

There are good reasons – emphasis on natural sciences, the existence of the science park Mjärdevi and the fact that the university is relatively young – to assume that Linköping University has developed good contacts with private business, perhaps even better then older and more traditional Swedish (or European) universities. Researchers are positive to commercializing and the overall ambition of the university is to encourage and stimulate the commercialization process. The two main supporting agents connected to the university are active and, at least in theory, should be able to support researchers in bringing their research to the market.

Despite this, there are still obstacles to commercialization and entrepreneurial initiative. Few researchers consider it meaningful to establish their own firms and the supporting functions at the university have obviously failed in making researchers more interested in entrepreneurship. The results indicate that the commercialization of university research could be made much more attractive (and successful), which probably means that there is an even larger potential at other universities.

This may be the cause for some concern since weaknesses in the university's support structure could influence the entire regional innovation system, thus leading to an environment less well-structured to foster and nurture the establishment of new technology-based firms. That the holding company at Linköping University is still working at marketing itself towards researchers must be considered a failure, considering that it has existed for ten years.

With increased resources and competency, the holding company could probably be put to better use. When compared to the Office for Technology Transfers/Management in American universities, the possibilities to deepen and extend the contacts with private business seem large (Braunerhjelm et al. 2000, Carlsson and Fridh 2002).[30] The results also show that researchers with information about the possibilities for support are more positive to establishing their own firms. Measures minimizing the time researchers themselves must devote to establishing and administering firms would possibly contribute to increased entrepreneurship. Obviously, the conditions for increasing entrepreneurship are not only shaped by universities, rather they are a combination of national policies and university-specific conditions (Nelson 2002). For instance, Link (1995) concludes that such policies were critical for the emergence of the North Carolina Research Triangle, and that it took a long time (50 years) for them to achieve the desired effects. Similarly, Mowery et al. (2001) and Rod (2006) note that universities without any Office for Technology Transfers may be quite successful in their commercialization activities, which reflects differences not only in university culture, but also in the economic milieu in which the university is embedded, and how well the innovation system works.

Without a general policy conducive to entrepreneurial activities and market experiments, the universities will not succeed in their commercialization activities. Thus, the results indicate that it is probably more important to strengthen the general prerequisites for entrepreneurship in Sweden, then shifting IPRs to the universities or setting up entrepreneurial training centers and holding companies.

Table 1. The size of different subgroups of respondents at Linköping University

Researchers who have	Number	Percent
- commercialized in corporations where the researcher is the sole owner or has a proprietary interest	13	6
- commercialized in corporations where the researcher had no proprietary interest	27	11
- who intend to commercialize	19	8
- not commercialized yet but believe there is a commercial potential in their research not yet exploited	86	36
- concluded that their research have no commercialization potential	92	39
Total	*237*	*100*

Source: RRV (2001).

Table 2. Researchers who report difficulties in obtaining relevant support categorized on researchers with proprietary interest on those without ownership

	Modes of commercialization by researchers	
Need for support	The researcher had no proprietary interest	The researcher was sole proprietor or had proprietary interest
I needed no support	57 %	8 %
Simple	10 %	17 %
Fairly simple	5 %	25 %
Neither difficult nor simple	14 %	8 %
Fairly difficult	14 %	17 %
Difficult	0 %	25 %
Total	*100 %*	*100 %*

Source: RRV (2001).

Table 3. Researchers' various motives for abstaining from commercialization

The research is still at a too early stage	13 %
Due to time constraints the researcher have not yet considered how/whether to take this step	61 %
The researcher does not want her/his research to be used in that way	4 %
The researcher report insufficient knowledge about how to proceed	4 %
Attitudes towards commercialization is negative on the respective department	5 %
Other reasons	13 %
Total	*100 %*

Source:RRV (2001).

Table 4. Participants in the ENP-program

	1994	1995	1996	1997	1998	1999–1	1999–2	2000–1	2000–2	2001–1
No. of participants	6	8	11	26	35	35	36	26	30	31
No. researchers (of the total)	1	1	6	12	13	8	9	4	5	7

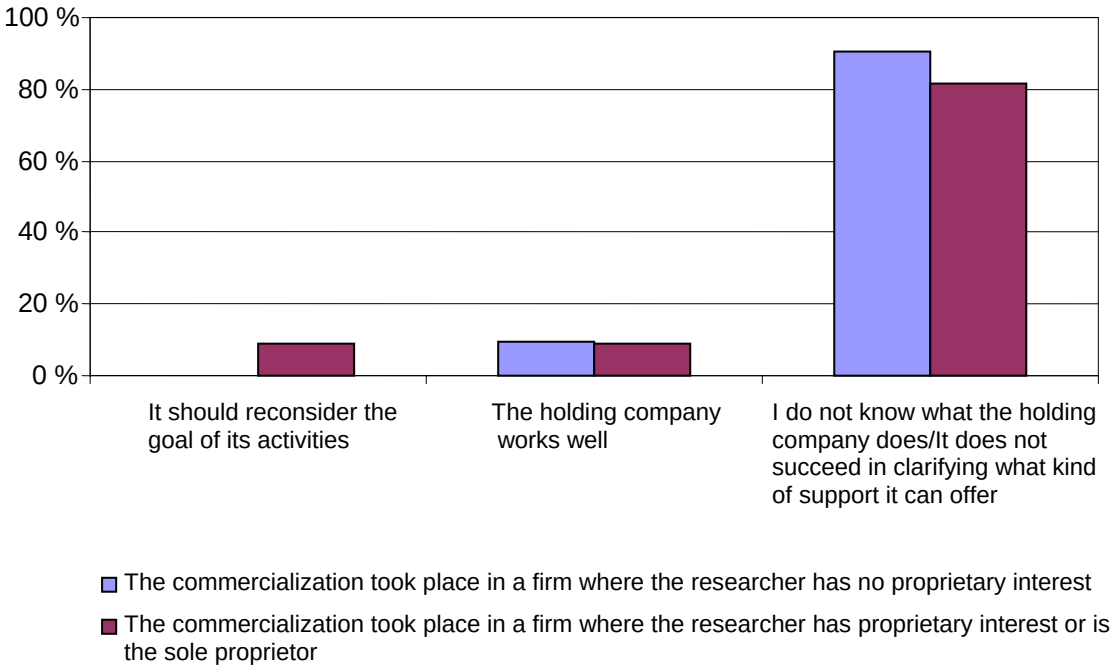
Source: Carina Schärberg at CIE.

Table 5. Researchers' (who intend to commercialize) knowledge of the support offered by Universitetsholding, percentage share

Researchers that know about Universitetsholding but have chosen not to utilize the support they can offer	22 %
Researchers who are informed about Universitetsholding and are interested in getting their help	17 %
Researchers who do not know what support Universitetsholding can provide	61 %
Total	*100 %*

Source: RRV (2001).

Figure 1. The view of Universitetsholding among those researchers who have commercialized their research results



Source: Data from RRV (2001).

Appendix

The relative share of high-technology start-ups (RELSHARE) is calculated as the share of high-tech start-up divided by all start-ups in the respective country, which is then divided by the corresponding share calculated for all for countries,

$$RELSHARE_{bj} = \frac{HT_{bj} / START_{bj}}{HT_{tot} / START_{tot}}$$

where HT refers to high-technology start-ups, START to all start-ups and the indexes *b* to the respective country while *tot* denotes the sum over all four Nordic countries.

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[3] See Phan and Siegel (2006) for a literature survey.

[4] Growth is of course also affected by a number of other factors which will however be disregarded here (Barro and Sala-i-Martin 1995, Carree and Thurik 2003, Acs et al. 2004).

[5] The dataset is based on a questionnaire that constituted the basis of a report (in Swedish) from the Swedish National Audit Office entitled *From Research to Growth – Government Support in Cooperation with University Colleges and Private Business* (Riksrevisionsverket 2001).

[6] As for most industrialized countries, the business sector accounts for the major part of R&D expenditures. For a discussion of the measurement of R&D, see Godin (2006).

[7] Swedish GDP fell for three consecutive years 1991-1993. Note that all countries having a large telecom/ICT-sector also report impressive growth figures, partly because of implementing so called hedonic price indexes when deflating production in those sectors.

[8] Note that he discussion about the "paradox" is related to the definition of R&D. Some countries may have a large D, which is related to middle technology industries, and a relatively small R. See Godin (2006) for a discussion of the R&D concept. As concerns the specialization of Swedish production see, for example, Andersson et al. (2006).

[9] Sectoral studies indicate that researchers at universities have obtained comparatively few patents. See, for example, Svensson (2002) for a detailed analysis of the medical sector and the sector for personal care.

[10] The data is accessed from Nås et al. (2003, p. 6).

[11]A later study by Lindholm-Dahlstrand (2007) indicates that technology based spin-offs seem to fare better more recently.

[12] Rosenberg and Nelson (1994), Abramson et al (1997), Cohen et al., (1998), Hall et al. (2002), Beise and Stahl (1999), Caloghirou et al. (2001), Miner et al. (2001). See Braunerhjelm (2007) for a survey.

[13] Basically the university "engagement" and the "triple helix" literature is addressed. For references, see Gunasekare (2006).

[14] A number of studies conclude that an evolution characterized by innovations, entry of new firms and dynamism, depends on the presence of a wide set of factors, ranging from a proper design of the legal framework and institutions (property rights, taxes, etc.), access to venture capital, relevant networks to complementary competencies, to culture, etc. (Dosi et al. 1988, Nelson 1994, 2002, Nelson and Winter, 1982, Acs and Audretsch 2003). Firm characteristics, informal channels, influence commercial collaboration with universities and the way in which knowledge is sourced (Meyer-Krahmer and Schmooch 1998, Fontana, Geuna and Matt 2003, Arundel and Geuna 2004). In particular, how well academic entrepreneurship performs should be related to the context in which it is embedded and the presence of - and interaction with - other complementary agents (Nelson 1990, Lundvall 1992, Nelson 1993, Edquist and McKelvey, 1996).

[15] In the U.S. most universities by now have well-developed system to handle patents and license revenues. Most have established an Office for Technology Transfer (OTT). Standard deals normally imply that researchers are entitled to third of the future income streams.

[16] See Braunerhjelm (2007) for a brief survey of the literature. See also Cesaroni and Picaluga (2002).

[17] The distribution is extremely skewed both with regard to universities and departments where patenting is a frequent phenomena (Nelson 1998, Mowery et al. 2001a,b). Biomedicine and biotechnology account for 41 percent of patents in the U.S., and the top five universities receive about 60 percent of license income (Rosenberg and Hagén, 2003).

[18] These faculties were deliberately chosen by RRV since it was argued research would have greater potentials for commercialization as compared to other disciplines.

[19] We do not have access to data on those who have not responded. According to the RRV, the answers are representative.

[20] The data also reveals that only nine percent of the researchers lack the rights to commercialize their research results.
[21] At the same time, it should be remembered that the information is based on the researchers' own evaluations, and that it is far from certain that they are correct in evaluating the market potential. In the end, it is the market that determines if a good or a service is commercially profitable.
[22] Numbers presented in the text, but not shown in the tables, are taken from the RRV database.
[23] Similar concerns have been expressed by Merton (1979), Nelson (2001) and Slaughter (2001), i.e. that U.S. universities will leave a highly successful track, characterized by openness, in favor of a more closed system, to a larger extent based on cooperation with the private sector.
[24] See Di Gregorio and Shane (2003) for a recent study on U.S. universities.
[25] See also Mowery and Ziedonis (2001), Mowery et al. (2001a,b) and Carlsson and Fridh (2002).
[26] Naturally, the sub-category "Commercialization is not possible" might also be of interest, since those researchers might be wrong, but lack of data mitigates further analysis.
[27] The information in this section is based on an interview with Anders Carlsson, Universitetsholding. Teknikbrostiftelsen is a regional, government funded organization with the objective of supporting the commercialization of university based R&D.
[28] According to information picked directly from the RRV report.
[29] See also Henrekson and Rosenberg (2000).
[30] Still, as shown by Mowery et al (2001a,b), a technology transfer office cannot be expected to yield considerable increases in university revenue or necessarily result in a substantial increase in patents and licensing. The mission of offices of technology must be seen in a broader perspective, including values within the university, signals to students and the surrounding economic environment (Carlsson and Fridh 2002).