

Why and how do researchers engage themselves in commercialization of research?

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Abstract

The aim of the paper is to develop a framework of governance structures based on of researcher motivations and structures to commercialize academic research into economic value. We do this by case studies of academic researchers who have considered commercializing their research findings in the field of stem cell biology. The empirical cases let us further expand the typology of governance structures for commercialization of research discoveries from academia to industry. The main finding is a number of collaborative governance structures between the researchers and industry with corresponding business models, indicating that many researchers prefer to stay in academia and use commercialization as a vehicle for enlarging their research inside and outside academia.

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Introduction

Research performed in the university system is generally seen as important for innovation, especially in high-tech sectors like biotechnology, in a knowledge-based society (Etzkowitz, and Leydesdorff, 1999). In order to facilitate and speed-up the knowledge transfer from university research to industry most developed countries, e.g., Germany, Japan, the U.S., have adopted regulations giving the intellectual property rights (IPR) to the universities, thus giving the universities the decision-making power how to commercialize research findings. From current research on research commercialization (e.g., Shane, 2001; 2002), mostly based on U.S. data, the universities predominantly seem to use two governance structures: i) the technology transfer office (TTO) structure where research is commercialized through licensing to the market (Markman et al, 2005) and ii) the entrepreneurial (or hierarchical) structure where a new venture is formed. Thus, current research focuses on either the TTO or hierarchical governance structure for research commercialization leaving possible collaborative structures aside (cf. Williamson, 1985).

A few developed countries, like Sweden, Finland and Italy (OECD, 2003), have decided to not adhere to the dominating norm of university IPR instead researchers in academia own the intellectual property stemming from their research and they have the decision-making power to commercialize their findings in the most suitable way to them. We may here talk about a researcher-governed system of research commercialization as opposed to the more commonly discussed and researched university-governed system.

To understand the variety of governance structures for commercialization of research may be especially important in commercialization processes which are based on new scientific knowledge like biotechnology. The biotech industry depends heavily on university research for innovation (cf. Stuart and Sorenson, 2003; Zucker, Darby and Armstrong, 2002) and collaborates extensively with university research (Powell et al, 1999). Research knowledge, especially from new scientific fields like biotechnology, is of a very generic character, demands much development and carries a high risk (Stankiewicz, 1994). Studies of research commercialization in contexts where the researcher governs the research commercialization process may reveal insights in other mechanisms and structures than currently discussed. Recent research on the U.S. research commercialization system also questions the efficiency (Litan, Mitchell, and Reedy, 2007; Powell, Owen-Smith, and Colyvas, 2007) and compliance with the system seems to vary considerably between universities, departments and individuals (Bercovitz and Feldman, 2008).

The aim of the paper is to develop a framework for main types of researcher motivations and corresponding governance structures to transfer academic research into economic value. We do this by case studies of academic researchers who have considered and taken actions in order to diffuse their research findings to be used in commercial settings. The empirical cases allow us to further expand and elaborate on the typology of governance structures for commercialization of university research and to move us beyond the current discussion on either spinoff- or license-based university research commercialization (cf. Shane 2001; 2002).

Our contribution to the research area is primarily the identification of several types of collaborative governance structures used by researchers wanting to stay in academia but at the same time responding to commercialization opportunities as well as opportunities to expand their research inside and outside academia. These collaborative governance structures seem to play an important role in university knowledge transfer, at least in biotech research, along

with market-oriented governance structures and entrepreneurial governance structures. Moreover, we show how the collaborative governance structures translate into important economic value for the researcher both in terms of economic compensation for giving up IPR and more importantly into sponsorship of their research and sharing of resources and competences between the company and the research unit in the university.

The remainder of the paper is structured as follows. First, we introduce the concept of governance structures in university research commercialization. Secondly, we present our six case studies of stem cell biology commercialization. Thirdly, the cases are analyzed and the framework is presented. Lastly, we discuss our contributions and limitations.

Governance structures in university research commercialization

Traditionally, scholars of organizations and management distinguish between two major types of governance structures - markets and hierarchies – where the firm stands for the hierarchy and the market stands for firms conducting market transactions (Williamsson, 1985). However, many scholars have observed that firms also engage in inter-organizational transactions such as joint ventures, alliances, minority holdings, licensing and other forms of alliance and collaborative structures (e.g., Gulati and Singh, 1998; Santoro and McGill, 2005). These different forms of collaborative structures could be placed on a continuum between the hierarchy and the market, where for instance joint ventures would be regarded as close to the hierarchy structure while a licensing agreement would be ranked more closely to the market end of the continuum (Santoro and McGill, 2005).

In a similar vein, we argue that governance structures in university research commercialization could be categorized along the same continuum. From a researcher point of view the choice to start-up a new firm in order to exploit some potentially valuable IPR would represent the hierarchical governance structure as the researcher's knowledge is internalized into the firm. If the firm is wholly owned by the researcher it would be a pure hierarchical structure while start-up firms which are partially owned by the researcher (and partially by others like the university, venture capitalists, fellow researchers) would represent a less hierarchical structure. The market structure in university research commercialization is represented by the researcher selling his/her knowledge (as patents or licenses) to the best bidder in the market. A researcher choosing to use the university's TTO as a marketing organization for his/her knowledge would still be an example of a market structure, however less so compared to the researcher making transactions directly with a buyer.

In sum we could in a researcher-governed system distinguish between four types of governance structures: the market structure, the TTO-structure, the wholly owned start-up firm structure and the partially owned start-up firm structure. Apart from the market structure the other structures are also well described and researched in the literature regarding university-governed systems. The market structure is very little discussed in the university-governed system as researchers are expected to disclose their research knowledge to the university TTO and they in turn are expected to commercialize the research knowledge.

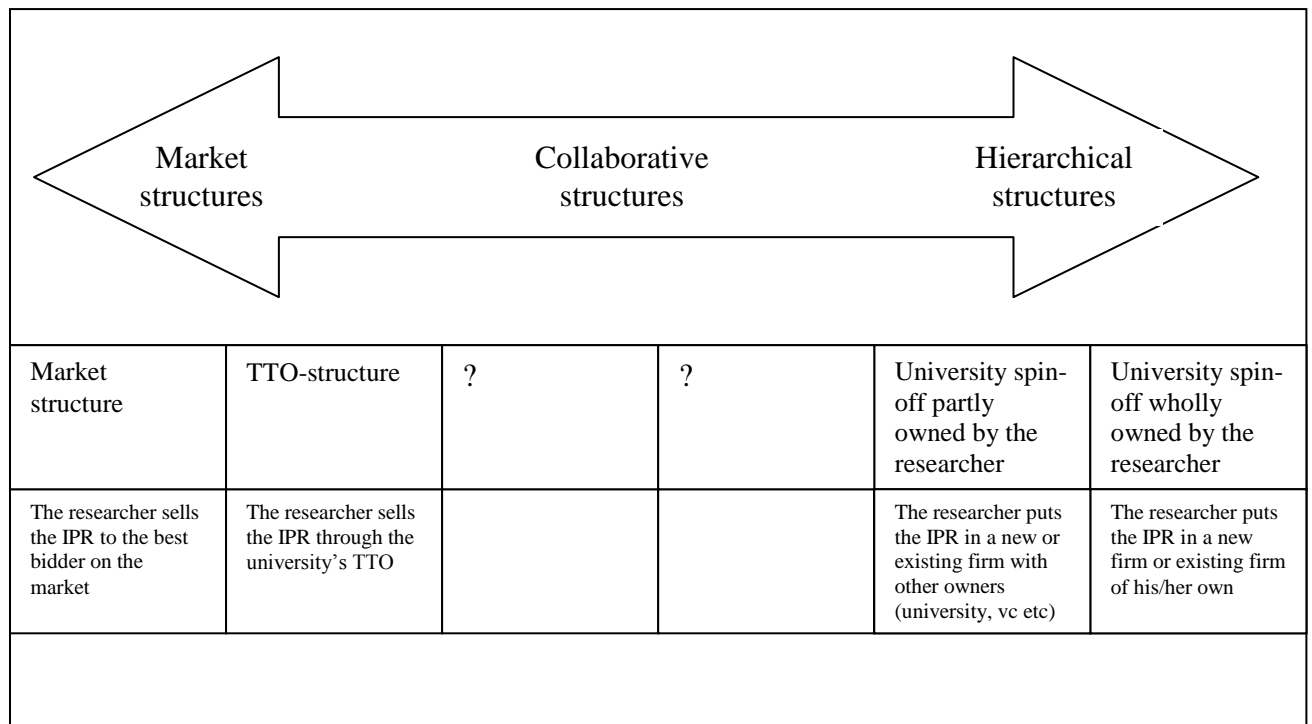


Figure 1. Governance structures in university research commercialization from the researcher's perspective.

While the TTO-structure and hierarchical structures (academic spin-offs) have been researched extensively in the university technology transfer literature the collaborative structures have largely been overseen in the university technology transfer literature as figure 1 indicates. This is surprising given that U.S.-based technology-transfer officers in a recent survey estimated that 71 percent of the inventions they licensed could not be successfully commercialized without further collaboration with university researchers (Thursby and Thursby, 2005). Moreover, a common field of university technology-transfer is biotechnology a field where innovation is characterized by various collaborative arrangements (Pisano, 1990). Thus, it seems surprising that university technology-transfer would not include different forms of collaborative structures, especially in fields like biotechnology.

Six case studies of stem cell commercialization

The scientific breakthrough of stem cell research is generally dated to 1998 when an article (Thomson et al, 1998) was published claiming that a group of scientists had managed to grow and keep alive human stem cells in vitro (outside the body) and they had started to differentiate into new cell types. Stem cells are a well-defined concept within biological research. Stem cells are undifferentiated, which means that they potentially could be developed into almost any cell or tissue. The human body consists of some 200 different cell types and each type can be cultured from a single immature stem cell. The only established stem cell therapy, used for several decades, is transplantation of blood-forming cells to restore blood formation after bone-marrow transplantation. No other therapeutic or commercial application had yet been developed from this research in 2006 when this research was performed. The commercial firms in the stem cell biology area are research firms trying to understand different human stem cells, e.g., brain, nerves, blood, muscle, bone, and ligament stem cells, and how they grow and differentiate. Because of its great potential and possible

revolutionary change of the traditional pharmaceutical industry it attracted a lot of commercial interest almost from the beginning of the scientific breakthrough. During the IT-boom at the turn of the century, some venture capital also found its way into biotechnology and into stem cell research firms, corresponding to a similar hype as in IT at the time.

There are several potential areas of application for stem cells; neurological disorders, tissue engineering and screening-processes for new drugs. For the purpose of this study, we did not make any limitations with regards to application. Instead we took note of how thoughts and actions regarding possible areas of application for each commercialization project emerge. In our definition of stem cell research projects we included projects within a variety of scientific fields, but limited our study to research where the stem cell and its potential use was the actual focus of the project.

Six case studies have been performed within the project; all six of them in Sweden at three major stem cell research centers at Gothenburg University, Lund University and Karolinska Institute in Stockholm. The cases are at various stages in the commercialization process (see below). In Sweden researchers own the IP according to the principle of “university teacher exemption”, i.e., exemption from normal patent rules. The Swedish universities normally have technology-transfer organizations (TTOs) that the researcher may use or not. In the former case a contract between the researcher and the TTO is normally signed regulating the ownership of the IP.

Originally leading stem cell researchers at the three stem cell research centers were approached to get general knowledge about the stem cell research performed at these three universities and also to get suggestions for candidates for case studies of commercialization based on or related to stem cell biology. These candidates for case studies could be at an early stage, only an idea for commercialization, or at later stages including patents and licensees already issued and spin-offs created. After contacts with several candidate projects we managed to secure access to six of these projects, three in Stockholm, two in Lund and one in Gothenburg.

The history of the projects has been mapped initially through interviews with the key people and related documentation and the projects have been followed over an 18 month period. Interviews have been performed with key persons in relation to the stem cell projects, primarily the researchers related to the commercialization project. Each interview session has been recorded and transcribed. The interviews have been mainly personal and in some cases by phone because of large geographic distances.

The six cases are in different commercialization phases as can be seen from the table below. The names of the projects are changed into neutral names in order to not reveal sensitive commercial information.

Project/Phase	Commercial opportunity recognized	TTO involved	Venture capital raised	Patents registered	Venture formed
Stockholm 1	Yes	No	No	No	No
Stockholm 2	Yes	Yes	Yes	Yes	Yes
Stockholm 3	Yes	No	No	Yes	Yes
Lund 1	Yes	No	Yes	Yes	Yes

Lund 2	Yes	No	Yes	Yes	Yes, part of an earlier established firm
Gothenburg 1	Yes	No	Yes	Yes	Yes

Table 1. Six stem cell commercial projects

Case Stockholm 1 (S1)

A researcher in Stockholm had for several years had contact with another researcher at another Swedish university. The Stockholm researcher (S1A) specialized into developmental biology and differentiation of cells, whereas the other researcher (S1B) specialized in making polymers and the properties of different materials. The S1A researcher sensed that this combination of knowledge could be developed into something commercially interesting. The idea was to develop a new polymer-based material which would provide better conditions for cell cultivation in laboratories than the present products used in research labs. In June 2005, the Stockholm researcher received a tenure track position and research funding for this project. A first joint publication from the project appeared in December 2005.

Concerning the motivation to engage in commercialization activities the S1A researcher says: *“I come from a generation, ..., who has been told how important it is for us to patent. When you spend a lot of years in the U.S., where all the universities patent, I am personally not involved in any patent, they are talking about it all the time.”*

However, he does not have any great confidence in his own commercial capabilities: *“I have worked with promoting music groups before and there I had to consult other persons in order to sell the groups. They had to tell me what was commercially interesting. I am 100 % sure it is the same thing in science, the things I believe are commercially interesting... is totally wrong and something completely different when asking a business person.”*

The collaborating researcher (S1B) admits that research is more important for her than commercialization:

“I have to admit that even though commercialization is an important goal, a more important goal is still to do publication so I don’t think that during the development we will compromise in that respect that is specific because we want to commercialize. I more see it that we will try to get the project in a direction that will lead to publication and then try to apply to commercialization. So maybe changes have to be done to the version that we develop for the publication. At least the way I see it is if there is an hierarchy a publication in a scientific journal is still higher than commercialization.”

The S1A researcher says that he will turn to the technology-transfer office at his university the day he needs commercial assistance and advice. This has partly to do with his low confidence in his commercial capabilities but also that he thinks he is entitled to take advantage of the services provided by the university TTO as his research money is paying for the overhead at the university. The other researcher (S1B) envisions her role in the commercial part of the project as helping out with providing data and helping out with the writing of the patent application:

“My primary work is to do the bench work, to develop the data. If we try to commercialize adjustments would have to be made to make it commercially. So I would definitely be involved in that aspect, changing that aspect of the project. But in terms of the actual legal side of it, I

understand that there is a lot of writing involved even on the scientific part, so that is definitely something that I expect myself to be involved in as well.”

Case S1 illustrates two researchers that due to their personal contacts and combination of two different knowledge fields have recognized a commercial and a research opportunity. They have capitalized on the research opportunity receiving special funding for the project. They are aware of the pressure from the university to patent and they have experienced the American system where the universities constantly are searching for patent opportunities. However, they are clearly research oriented and value a research career higher than an entrepreneurial career. Their low self esteem regarding commercialization capabilities and limited commercialization experiences make them hesitant to pursue the commercialization project themselves. Instead they envision involving themselves in the technical development of the product and assisting in writing patent applications.

Case Stockholm 2 (S2)

The researcher in S2 had discovered how to speed up the production of certain cells needed for bone marrow transplantation using a specially developed “cocktail”. This cocktail also made the production of cells much cheaper and with higher quality than the present process. The TTO at the university contacted in order to interest him to be a part of a new venture where the TTO would place a number of commercially interesting projects and researchers in this venture. The researcher agreed and eventually the TTO managed to connect ten researchers who brought in different projects and in return got shared ownership in the new venture. The new venture was then funded by university initiated venture capital fund and a professional management and board was attached to the venture through the contacts of the TTO and private investors. The cocktail-project has developed further since it became associated with the venture and has entered in the Phase 1 clinical trials. The people working in the venture consist mainly of researchers that work at the university, thus the venture and the university share personnel.

Taking part of the new venture and receiving venture capital funding for the research project is for the researcher a way of getting more resources to his research group at the university. Both his peers and the university management generally hold the opinion that involvement in new ventures is an acceptable practice in order to secure financing for her academic research. Thus, S2 is a case of sponsored research, more specifically the “first right of refusal”, meaning that the venture has the option to acquire the researcher’s intellectual property from any finding associated with the specified project. The researcher did not recognize the commercial opportunity himself, instead the TTO and the venture capital fund at the university recognized the opportunity, organized it with other research projects and researchers and then arranged the financing.

Case Stockholm 3 (S3)

S3 involves two key researchers (S3A and S3B) at the same university working as a team in their pursuit of commercialization. Their research involves understanding a special cell in our brain and how it is formed; the dopamine cell. The researchers in S3 have managed to develop a method which will differentiate embryonic stem cells into dopamine cells. Hopefully these could be used in a therapy to stop or reverse the Parkinson’s disease in the brain. Another

possible application is to licence the method to produce dopamine producing cells which could be used by pharmaceutical companies in their drug screening process.

The two researchers have previously not been involved in any commercial activities except for some occasional consulting. They have had many contacts with U.S. research so they are well aware of the interest for commercial application. Their contacts with their own university's TTO have been limited. Their motivation for commercialization of their discovery is a mix of duty, feeling important and of becoming rich:

"I think it is our duty to bring this to application if someone wants to use it. And then of course, we in Sweden have the teachers' exemption which means that we own the right to our own discoveries and you wouldn't be sorry if you could earn some money too." (S3A)

"It is rewarding for the first time to be able to, in a simple way, explain what your are doing to people....the man on the street wants to know which decease you are working on and what this is good for... If you are working with basic research it is not so easy to explain what applications and cures your research would be good for." (S3B)

The researchers have chosen to file a patent application for the method. For help with the patent application the two researchers turned to a non-commercial organization outside the university. They received financial support to cover initial costs of the patent and have an option of taking back the patent as long as they pay that money back. The contact with the patenting supporting organization came from one of the researchers, who has been involved with the organization before. They decided not to engage the TTO at their own university, believing they would loose too much money and control when giving up a part of the company.

"XX Innovation (the university's TTO – our remark) charges rather much, I think 25 % or so (equity – our remark). The cost for a patent is initially 40-50,000 (SEK – our remark) and then after a few years the cost will become higher. But for 40-50,000 to give away 25-30 %, why should you do that?" (S3A)

The researchers have tried to get as much "free" advice as possible from colleagues or other people in their network who have experience of commercial activity. The researchers in S3 hope to earn substantial amounts of money through their commercial pursuit but not to involve themselves heavily in the commercialization activities themselves.

"I would prefer an existing Biotech-company to step in and really believed in the concept and then that they would be the rights for such a big amount of money, that even if it wouldn't work in the future, it would completely have changed my life. In principal I would be financially independent and regardless what would happen I would not have to worry at all about my pension." (S3B)

"If this would become something and you could see that several other companies are interested in this, then you have to think about getting some help. Forming a company and then have consultants who help you. I would definitely not spend much time on it myself." (S3A).

The researchers say that they are well funded and have all the equipment they need to continue their research, thus there is no need for them to get extra funding for their research. Also, their research has already shown proof-of-principle, i.e., that their method to produce dopamine stem cells works on mice stem cells and they have already a publication accepted for this work. To make the method work on human stem cells and with consistent quality is just a matter of "technical development" and less rewarding from a research perspective and something they hope a biotech company would be interested in doing. They have, through American colleagues, been in contact with an established U.S. biotech company in order to discuss possible partnership and/or licensing of their patent.

Case S3 shows that the researchers have a rather clear motivation to earn money and get rich on their discovery. They are not interested in additional research funding. Instead they want to get royalties on their patent or possibly sell it and let an established company take care of the commercialization process. Their university's TTO have not been involved because the researchers think they can manage themselves together with the help of friends and another organization in that way retaining control and sole ownership of their discovery.

Case Lund 1 (L1)

L1 involves a researcher of the causes of Parkinson's disease and how to restore the production of dopamine in the brain. He (L1A) has published more than 600 articles and also worked as a consultant for several pharmaceutical companies interested in various neurological diseases. A company researcher in one of those companies, company NS, contacted him in 1999. After some discussions, the company researcher and L1A jointly proposed to the top management of NS to start a new venture where research was performed in various neurological diseases using knowledge regarding stem cells, genes and brain cell transplantation techniques. The university researcher motivates his interest in a new venture:

"I want more research to be performed in this area and this is a way to get more funds for the research and hopefully progress both scientifically and in practice....We can do the research work, at the academic level, the part that is more explorative, to establish principles and what you call proof-of-concept. When you get into the development phase and get products that are tested and approved to use on patients, then it gets so expensive that it becomes necessary to have a commercial partner. " (L1A)

The proposal was put to the company NS' management and board and received a positive response, given that enough venture capital could be raised from other sources. NS was not willing to take the risk alone. Several venture capital companies were approached through the NS company network. L1A took part in these presentations, endorsing the proposal for a new company and the research that was going to be performed. Six different venture capital companies agreed to invest. L1A is regarded as the venture's (NG) scientific founder but he does not own any shares in the company. Through the years he has never applied for a patent, even though he had several opportunities to do so. L1A describes his role:

"As a pure advisor and collaborating partner. We have run some projects together. That is all. We have some competencies, resources, equipment and methods that they don't see any value in investing in, it is too expensive... They have also recruited two of my staff from here." (L1A)

"I am not involved at all on the business side, I help out whenever I think it is necessary. I have no background in business. It is also good with a clear division of roles, that the company and the university department have separate roles, I don't mix them, they are completely separate." (L1A)

The NG venture and L1A interacted frequently in the beginning, performing several stem cell research projects together and researchers from the group took up work in NG. L1A and the research director in NG took initiative to apply for EU-financed programs regarding Parkinson and stem cell differentiation. After a couple of years it became clear that stem cell research had a long way to go before it could be used in cell transplant therapies which was the original idea. They had however filed for six patents relating to cell differentiation methods in the process of producing dopamine-producing brain cells. NG experienced a breakthrough in another project, not involving stem cell technology but rather gene technology. The NG management and board decided that the stem cell research should be limited only to the areas which were EU-sponsored

and that most of the resources would be allocated to the successful project. Almost all research in the stem cell area is now performed within the university research group. At present there are mainly contacts within the EU-sponsored program.

“The project has evolved from earlier being very active to a very low level, it is now driven only at the academic level. But NG is there and could seize opportunities and guard its position.” (L1A)

L1A has informal contacts with the management, mainly for exchanging information about what is happening in the Parkinson research field. The NG management was at the end of the study trying to sell or license their patents to other biotech companies as they contemplated shutting down their stem cell activities at the end of the EU-sponsored research program.

The L1 is a case where the researcher’s commercial motivation springs from a vision to enlarge the financial and other means for further research and assist in the bridging of research knowledge to more application oriented knowledge. The initiative is taken by a fellow researcher working in industry. The project generates opportunities for the company to use competence, equipment, other resources and trained personnel from the university. The university researcher also assists in raising venture capital for the new venture using his academic status. The research group and the company also gets opportunities to take part in EU-sponsored research programs.

Case Lund 2 (L2)

The researcher in L2 (L2A) is a pioneer researcher into human stem cells and responsible for isolating and characterizing several human stem cell lines that research could be performed on. He is one of the founders of one of the first stem cell companies in Sweden (CA) together with some fellow researchers. The researcher explains that:

“The reason for us to start that company was that we wanted a way to finance the academic research.” (L2A)

“I have also been dependent on the company because they developed embryonic stem cell lines and I couldn’t do that in my own university lab and I didn’t have any resources to build my own embryonic stem cell lab.” (L2A)

L2A is primarily involved in beta cell research and in the end find a way to cure diabetes. He is now one of the world’s leading researchers in beta cells and receives regularly research funding from international foundations with the aim of finding a cure for diabetes.

“I think the part of creating a drug is not very important in my research. However, it would be fun if you could use these cells to something useful too, but I can’t take these cells that far, my job is to isolate and develop cells that are good to work with. And then you would like to see them brought to use and created some type of product that you could treat patients with.” (L2A)

The CA company is primarily interested in beta cells as a screening device in drug development and not to find possible cures for diabetes which they deem is a very risky and long term project. L2A is bound by contract to disclose any interesting research results that come up through his research at the university to the CA company. If someone in his research group comes up with commercially interesting results, the company can offer the researcher stock options in the company as compensation for the intellectual property right. L2A is also a member of CA’s board, which gives him a good position to coordinate research between the company and his own group. Roughly half of the research concerning beta cells is performed in his research group and the other half in the company. In all some 20 people are involved in the research. Researchers are often exchanged between the company and the research group. Some of the

research is sponsored through EU-programs on diabetes research where the researcher is one of the coordinators in European network of diabetes researchers and the company is one of the commercial partners in the network.

The L2 case shows a researcher motivated primarily by enlarging the funding for research and creating complementary resources for university research. While he is one of the founders of the company and subsequently owns a small part of it, the chance of becoming rich does not seem to interest him very much. Instead he takes active part in the company and through the board and other contacts in the company coordinates the research performed in his research group and in the company and also through EU-research programs organizes funding for the company's research.

Gothenburg 1 (G1)

This case involves one researcher that had a PhD in stem cell biology and, after a post doc period in the USA during which he had gained both academic and industrial experience, he was more tempted to use his experience in industrial projects than to return to the Swedish academic setting. He found it especially interesting to work in a small firm where he as a young researcher possibly could become responsible for a larger part of the development process and derive new applications from the basic research. In this case the researcher went as far as to leave academia for a position in the company. The decision to leave academia was facilitated by a public policy initiative, in the form of financial support, which made it beneficial for an established but young research firm to employ a returning expatriate researcher.

The researcher was involved in developing a method needed for the quality assurance of the company's products. This method showed such large potential that the company management decided to place it within a new company, which would be managed by the researcher and two colleagues. This spin-off developed successfully and was subsequently acquired. The researcher then returned to the mother company for a period before moving on to another start-up company. All the three companies (the mother company and the first and second spin-off) have all been tightly linked to academia. This has meant that the researcher has continuously kept a close link with both the university research as such, and with his former department in particular.

The G1 case shows a researcher primarily interested in commercial development and to work in industry. While this is not a case of a researcher starting his own new venture he does take on entrepreneurial tasks to start-up new ventures. He is clearly motivated by working in industry and develop new commercially interesting applications. At the same time collaboration with his old research department seems vital to his work and ability to develop these applications.

Analysis of cases – the researchers' motivation to involve themselves in commercialization and how is commercialization structured

The six cases differ in both researcher motivation and the governance structure they choose to organize the commercialization process. In S1 the researchers are highly research oriented and believe that they have no commercial capabilities or contacts themselves. Thus, they plan to use the university's TTO and carry on their research with minimal involvement in the commercialization process itself. The commercialization project also seems to have little if

any effect on their research. The S1 case resembles “the drop-off at the TTO”-case often described in the literature on research commercialization (cf. Markman et al, 2005). The S3 case is to some extent similar to the S1 case as the researcher in S3 basically just want to drop it off at the highest bidding company. They feel they have enough competence and contacts to manage the drop-off instead of taking the help of the TTO. Also the S3 researchers are research oriented, they do not wish to become entrepreneurs and to start their own venture, but certainly to be financially well compensated for their discovery. The S3 commercialization project seems to have little effect on the research and is not motivated for research funding reasons.

The other three cases (S2, L1 and L2) all share the characteristic that the key motivation for the researcher is to get more funding to and complement their own research. They differ in how active the researchers are in the commercial part of the process and in the venture/company formed to organize the complementary funding and research activities. In S2 the commercial activities are initiated by the TTO and the research project organized with other commercially interesting projects and researchers. The researchers become part-owners of the venture but not involved in the management or board of the venture. The research continues at the university in the research group (with more financing) but the company has the option to acquire the researcher’s intellectual property from any finding associated with the specified project. While this case is close to the TTO-case the researcher is somewhat more involved as he is a part-owner of the venture and also part of larger commercialization effort.

The L1 case shows a researcher that is motivated by extra funding and complementary research resources but here he is more active in the commercial part of the process. Also here the initiative comes from the outside, from a research colleague in the industry. The researcher helps out with raising venture capital, gives advice and shares resources and competence. He does not take any ownership, but could more than likely had done so if he had wished. Instead he is the scientific founder of the new venture. The L2 case shows the most commercially active researcher in the sense that he is part-owner of the company, active on the board of the company, shares and coordinates resources and competence between the company and his own research group. Still he falls short of being a full-fledged academic entrepreneur as he stays on in academia and does not take on full responsibility for the company.

The G1 case is the one coming closest to the entrepreneurial model were a researcher starts his own new venture. In this case he takes up work in a young and newly established research firm and subsequently assists in this firm’s development of two new applications that is placed in two new ventures. In comparison to the L1 and L2 cases the researcher in G1 has chosen to leave academia and work in industry motivated by the work in the more commercial phases of the development process.

The framework: Governance structures of research commercialization

Using the framework of governance structures in university research commercialization presented earlier in this paper we may categorize the commercialization projects along a market-hierarchy continuum. First we have the market structures with researchers wishing to involve themselves as limited as possible in the commercialization and for financial or other reasons wishing to transfer their discovery or invention to a more competent actor/highest bidder. The S3 is a case where the researchers freely look around for the highest bidder/best solution for their discovery. In S1 the researchers feel restricted to use the TTO primarily because of lack of knowledge of alternatives.

Secondly we have the hierarchal structure or entrepreneurial structure where the researcher involves herself in the commercial process through ownership and/or activities in relation to a new venture or established company. The full hierarchical structure would be a case where a researcher (or team of researcher) would start and own a new venture and involve herself in management and/or board activities. In the G1-case the researcher leaves academia and joins an entrepreneurial firm to develop new applications.

Third, we have three cases which could be characterized as having various collaborative structures. The most limited collaboration, between the researcher and the commercial partner is illustrated in the S2 case which could be labeled as “sponsored research”. At the other end we have the L2 case in which the researcher takes a more active role in the company and also has an equity position in the company. In the L2 case the researcher tries to “manage both sides”, managing both the university research group as well as the research performed in the company. In L1 the researcher stays in the university organization but occasionally assists the company to facilitate the “bridging” between basic research and the more commercially oriented applied research. The framework and the cases are summarized below.

Governance structure	Market structure	TTO structure	Collaborative structures			Hierarchical or entrepreneurial structure
			Sponsored research	Bridging	Managing both sides	
Mechanism of commercialization	Licencing/selling of IPR to highest bidding company	Drop-off to TTO	Sponsored research	Bridging	Managing both sides	Researcher(s) starting new venture
Researcher motivation	Best at research, limited business experience, earning money	Best at research, limited business experience, comfortable with TTO	More funding to research	More funding to research, complementary resources, assisting in developing applications	More funding to research, complementary resources, assisting in developing applications, influencing company research	Developing commercial applications
Business Model	IPR-based	IPR-based	Mixed: Transfer of IPR, sharing of competence and resources, equity-position	Mixed: Transfer of IPR, sharing of competence and resources	Mixed: Transfer of IPR, transfer of competence, sharing of competence and resources, equity position	Equity position, licencing
Case study	S3	S1	S2	L1	L2	G1

Table 2. Framework of governance structure and corresponding cases.

Concluding discussion

Audretsch et al (2006) and Bercovitz and Feldmann (2006) argues for a broader understanding of university-industry technology-transfer where different actors motivations and incentives are accounted for. While Bercovitz and Feldmann (2006) have a broader set of technology-transfer transactions than the usual spin-offs and licences, e.g., sponsored research and hiring of students, they still do not go into any detail regarding the researchers' motivations and business models. One reason for this is that they take the American institutional environment for given with its emphasis on university owned IPR and the obligation for researchers to disclose any commercially important discovery and invention.

The case studies reported here show a greater variety of governance structures in part due to Swedish researchers' freedom to choose how they want involve themselves in commercialization. Apart from the obvious alternative to by-pass the TTO and go directly to industry for licensing the case studies have also revealed several collaborative structures between the market structure and the hierarchical or entrepreneurial structure. In the market structures (directly to industry or via the TTO) the researchers are mainly interested in staying in academia, believing that they have very limited possibilities to become good entrepreneurs. They have an interest in seeing their discoveries coming to use but they do not think they can play an active role in this part of the process.

In the more collaborative structures like L1 and L2 the researchers have a stronger motivation to assist in the process of developing applications and in commercialization of their discoveries. Their main motivation is, however, to enlarge and expand their own research, both inside and outside academia, taking advantage of the financial assets and resources created by the company. Finally we also had an example of a researcher wishing to leave academia, in G1, and to develop new ventures and new commercial applications.

Our results are more in line with Mazzoleni and Nelson (2005) that argue that it is a mistake to assume that commercial opportunities flow directly from fundamental research. In their survey, industry respondents said that general research findings, instruments and techniques were far more important for their business than prototypes. This held true even for respondents within the pharmaceutical companies. Industrialist reported that their main use of university research was to solve problems in R&D projects, rather than to trigger new R&D projects. Although university patents are seen as an important vehicle for technology transfer, pharmaceutical industrialist rate publications, meetings and conferences as even more important vehicles of gaining access to university research results. In line with this, Lester (2005) argues that the focus on technology-transfer offices should be replaced with a more differentiated view: The universities need to be aware of innovation processes in local industries and, along with pursuing front-line research, identify which role to play in those processes.

While we believe that the variety of governance structures identified here is partly due to Swedish institutional environment allowing university teachers to commercialize as they see fit, there may also be other factors influencing the result. Most importantly is to recognize that the stem cell biology research area is very new and thus most of the commercialization applications lie in the distant future. The general knowledge regarding stem cells is still limited thus a collaborative approach from the researchers might be called for, in order for this field to move anywhere near application.

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