INVENTIVE OUTPUT OF UNIVERSITIES: DIFFERENT PATENTING PATTERNS IN FINLAND AND FLANDERS?

M. Meyer[*] [a,b], T. Goloubeva[b], M. Du Plessis[a], J.T. Utecht[b]

[a] *Steunpunt O&O Statistieken, K.U.Leuven, Dekenstraat 2, B-3000 Leuven, Belgium*
[b] *SYO - Finnish Institute for Enterprise Management, Helsinki, Finland*

This paper compares the inventive output of two science systems in small European countries. More specifically, academic patents of Finnish and Flemish university researchers are studied. Inventive output as such and its concentration on organizations, inventors, and corporate owners are examined. In addition, the comparison includes other characteristics, such as foreign assignations and the degree to which individual inventors have retained the ownership of the patents. Finally, technological specializations are traced. While there are commonalities between the Finnish and Flemish systems in terms of patent concentration on key institutions and corporate assignees, there are also pronounced differences with respect to assignation structure and individual ownership of academic patents. The paper suggests that these differences can be associated with different collaborative and transfer structures that are related to the different intellectual property regulations in universities in Flanders and Finland.

1 Introduction

There has been growing interest in the economic utilization of research results. Along with the increased interest in capitalizing academic knowledge, collaboration between university and industry has received considerable attention by policy makers as well as decision makers in science, technology and innovation policy. Along with this trend, the bibliometric community has developed a number of approaches to meet the increased need for information about the contributions of the science system in general and university researchers in particular to the development of the national or regional innovation system. There are various approaches as to how one can study exchange between science and technology. One can distinguish three different aspects of science-technology interactions (*Meyer*, 2002a, b). First and foremost, one has to mention linkage bibliometric approaches that establish a connection between science and technology by tracing the science references in patents, as pioneered by Narin and his colleagues at CHI Research (e.g. *Carpenter and Narin*, 1983). As *Smith* and colleagues pointed out patent citation analysis is the most popular analytical approach to investigate how science and technology relate to each other (*Smith* et al., 1998). Developments towards the entrepreneurial university (see e.g. *Etzkowitz* et al., 1998) have revived the interest in the technological activity of university researchers, often traced studies of university patents. There have been a considerable number of such studies using quite different approaches (see e.g. *Henderson et al.*, 1998; *Meyer-Krahmer* and *Schmoch*, 1998; *Schild*, 1999; *Meyer*, 2003). While some studies focus exclusively on patents assigned to, that is, owned by, the university, other approaches are more inclusive and attempt to trace all patented technologies invented by university researchers. These studies include also patents that are invented by academics but not owned by the universities or their funding agencies. In this sense they tend to reflect collaborative efforts between researchers and industry to a larger extent. This paper presents data using this more inclusive approach, drawing on studies carried out independently in Finland and Flanders.

[*] Corresponding author, email: martin.meyer@econ.kuleuven.ac.be, martin.meyer@syo.fi.

Martin Meyer, Tatiana Goloubeva, Mariette Du Plessis and JanTimour Utecht, *Inventive output of universities: different patenting patterns in Finland and Flanders*?, In: Guohua Jiang, Ronald Rousseau, Yishan Wu (Eds), Proceedings of the 9th International Conference on Scientometrics and Informetrics – ISSI 2003, Dalian University of Technology, Dalian, China, 2003, 401-410.

In particular, this paper attempts to explore the commonalities and differences of university-related patenting for these two innovation systems that are characterized by different intellectual property rules in the universities and also different transfer practices. University-related patents are defined as those patents that were invented by at least one inventor who was employed by a university. The paper is structured in the following main parts. First, background and methodology are introduced. An overview and comparison of key results for Finland and Flanders follow. Finally, conclusions will be drawn with respect to potential implications for collaboration and analytical problems that need to be addressed in future research. A critical summary of the limits of informetric analyses as a way of tracing useful collaborative research efforts will conclude this paper.

2 Method, Data Sources & Limitations

Our analysis is based on two sources of data: patents and personnel register records. We compiled personnel register information for all major universities in Finland and Flanders and utilize databases of Finnish/Flemish USPTO patents. A patent was considered Finnish if Finland occurred either as the inventor country or as the assignee country in at least one instance. A parallel procedure was applied to identify the Belgian patents. The Flemish patents were selected based on Flemish municipalities in the address fields. As the initial studies on which this paper is based were independent from each other, different time frames were used. In Finland a database of US patents granted between 1986 and 2000 was available for analysis. In the Flemish study, the database included the years 1991-2001. Only utility patents were considered in both analyses. Design or any other patents were excluded.

Personnel registry information was obtained from Finnish and Flemish universities. For the Finnish data we had personnel register information available for the most recent year (then 2000 or 1999) and for 1997, the year in which most patents were filed. In Flanders, personnel records were available for the past ten years. Every university tends to have its own format. Therefore, the personnel data was cleaned and standardized. Doubles were removed. Names with unusual letters, such as the Scandinavian *å* or *umlauts*, were cleaned. The matching procedure was based on cleaned names from the personnel registries and inventor names as listed in our patent databases. The matching procedure is based on researchers' last names and initials. As bibliometric matching procedures lead to inventor/researcher name pairs that may link different individuals with the same name, a manual validation procedure was carried out to ensure that the databases of university-related patents were cleaned of homonyms. The same validation procedure was applied to both Finnish and Flemish data.

A number of limitations need to be considered when comparing these two datasets. A direct comparison must necessarily suffer from different delineations of the data sets. On the one hand, personnel register data was available in Flanders for an entire decade while Finnish universities made available only two years of personnel registries. On the other hand, the Finnish and Flemish USPTO databases covered different periods: 1986-2000 (Finland) compared to 1991-2001 (Flanders). This will obscure the comparison to some extent. For the comparison of total inventive outputs, the analysis was restricted to years only when both Finnish and Flemish data was available.

As a further restriction, there are innovation system-related issues to consider when comparing the inventive technological output of the two science systems. While Finland and Flanders have approximately the same population (about 5.5 million), there are considerable

differences with respect to overall patent output, venture capital investment, and the university system. For instance, Finland as a country achieves comparatively high patent rates.[†] There are also more researchers and young Ph.D.'s per capita than in Belgian and Flanders. Government investments in the science system as well as total R&D efforts appear to be higher in Finland. The country also appears to outscore Flanders/Belgian in most other STI indicators with the notable exception of venture capital provision (European Commission, 2003). These factors can all have an impact on the extent of academic patenting and their degree of utilization.

3 Results

This section presents a comparison between Finnish and Flemish academic patents in particular with respect to the following indicators: total inventive output; concentration of inventive activity on key universities; concentration of inventiveness within the universities on key individuals; rate of ownership of university-related patents by technological area and university (degree of assignations of patents to industrial companies or other organizations in comparison to unassigned patents); foreign assignation of university-related patent; and specialization of university-related patents by technological area.

3.1 Total Inventive Output

The total inventive output of ***Finnish*** university researchers is relatively high. We identified a total of 530 patents which could be related to university researchers as inventors. This is more than 8 percent of all Finnish US patents in our database. A total of 379 US patents could be linked to ***Flemish*** university researchers following our approach. This is about 5 percent of all Flemish patents in the Flemish US patent database. If one restricts the comparison to the years for which both Finnish and Flemish data is available (1991-2000), the patent counts are 432 Finnish patents vis-à-vis 311 Flemish patents.

The difference in absolute terms appears not to be surprising if one compares the total inventive outputs of both university systems, there are 1.4-1.5 as many US patents in Finland as there are in Flanders. This corresponds approximately to the difference observed in per capita US patenting between Finland and Belgium. However, one should bear in mind that ten years of personnel registry information were available for analysis in Flanders and only two years in Finland. Even though the validation process appears to indicate that no inventors with above-average activity were missed in Finland, the total number of Finnish patents may be higher. This would correspond to the relatively larger Finnish science system.

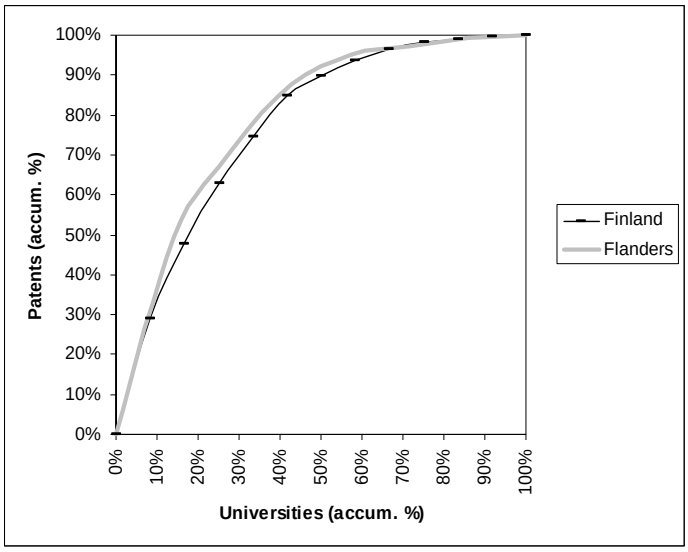
3.2 Organizational Concentration

In spite of the considerable differences in terms of STI indicators and the intellectual property (IP) systems, individual academic activity appears to be highly concentrated on a small number of universities. One or two universities, or one sixth to one seventh of the universities in either country or region, seem to account close to, if not more than, half of all university-associated inventive activity. In ***Finland***, almost half of all 530 patents can be related to researchers working in only two of all twelve universities. About three quarters are associated with researchers in four universities. In ***Flanders***, academic patents are even more

[†] According to data compiled by the European Commission (2003) , Finland has between 92-130 US patents per year and million population, compared to 59-88 for Belgium [1995-1999])

concentrated on researchers from key organizations than their Finnish counterparts. The Catholic University of Leuven accounts for about half of all patents. Figure 1 compares the concentration of patenting on universities.

Figure 1 Patent concentration on universities

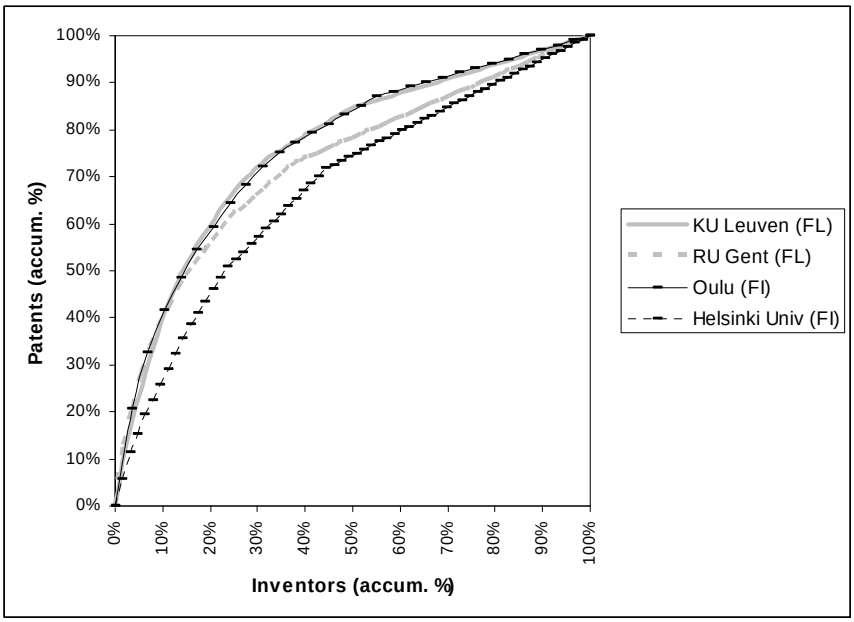


3.3 Patent Concentration on Inventors

While inventive activity is concentrated on a relatively small number of inventors, the Finnish universities seem to exhibit more variety in the concentration of academic patents on inventors than their Flemish counterparts. This is illustrated in Figure 2 for a selection of Finnish and Flemish universities that represent those cases with the strongest ad the least concentration of patents on academic inventors. The *x*-axis describes the accumulated percentage of inventors (in descending order) while the *y*-axis gives the accumulated percentage of patents. This way one can see how many percent of inventors invented a certain percentage of patents. KU Leuven in Flanders and Oulu University in Finland exhibit the strongest inventor concentrations in an almost similar pattern. The top ten percent of the inventors account for more than forty percent of the patents associated with the universities. While in Flanders, the case of least inventor concentration (RU Gent) shows at this level no difference, the top ten percent of inventors at Helsinki University and Turku University (here not displayed) in Finland accounted for only a little more than a quarter of the patents. All in all, KU Leuven and RU Gent concentrations are closer to each other than the concentrations observed for the Universities of Oulu and Helsinki, which seems to indicate more variety of Finnish universities with respect to inventor concentration.

So, what could explain the differences? Has the intellectual property regulation in Flanders a smoothing, leveling effect? Are different technological (and scientific) profiles and hence different technological patterns of inventiveness are possible explanation? Or could varying IP policies of universities explain the differences between Finnish institutions? We have shown elsewhere (*Meyer et al.*, 2003) that the Finnish universities have a very varied technology profile. In addition, observers point to different approaches and attitudes towards technology transfer and universities in Finland (*Kutinlahti*, 2003). In Flanders, universities tend to have a more 'homogeneous' patenting profile (see e.g. *Du Plessis and Meyer*, 2003) even though transfer activities still differ in their extent.

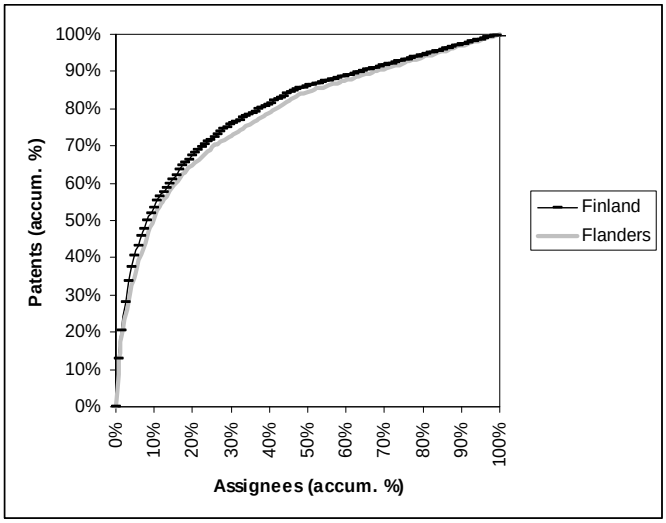
Figure 2 Patent concentration on academic inventors with selected universities



3.4 Patent Concentration on Assignees

While the assignee concentration is comparable to Finnish academic patents in Flanders (see Figure 3), there are considerable differences in the assignee structure. The differences are not unexpected because of the different intellectual property regulations in Finland and Belgium. In Finland the academic researcher retains the right to patent his or her research results whereas in Flanders academics have to file invention reports to the university's transfer organization which then pursues patenting this seems reasonable.

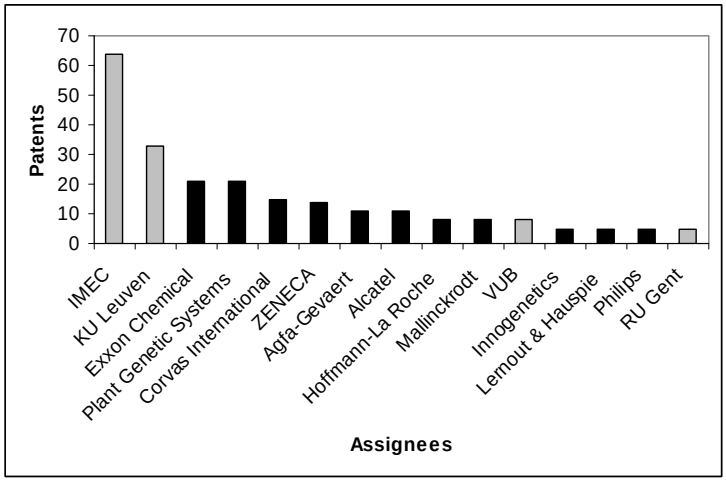
Figure 3 Patent concentration on assignees of university-related patents



Finnish university-related patents are concentrated on a relatively small number of assignees (i.e., owners). The top twenty percent among the corporate-owned patents can be associated with about 70%. Nokia is with 56 university-related patents the largest owner, followed by Orion (33 patents) and Valmet (33). Fortum (24), Instrumentarium (17), Kone (14) and Ahlstrom (11) are the next largest firms. All of the aforementioned companies are large, established firms. Helsinki University Licensing (now Licentia) is the next with a total of 11 patents in the database. This raises the question to what extent academic entrepreneurs use patents to protect their inventions.

In *Flanders*, university or other public research organizations feature much more prominently among the list of assignees. This is not a surprising result. What may be surprising is the relatively strong position of non-university assignees. This indicates that collaborative modes of technology transfer do play a considerable role also in systems in which universities own the intellectual property rights to their employees' research. However, a mere analysis of the patent data cannot identify the extent to which university patents have given rise to start-up companies or the degree to which they were licensed to other organizations.

Figure 4 Assignees of Flemish university-related patents



Note: Universities and public research organizations are shaded in grey. Only organizations with 5 or more patents are included.

3.5 Foreign Assignations

Expected differences can be traced with respect to foreign assignations of university-related patents. In *Finland*, about 13.8% or 14.2, or 73, of all university-related patents are assigned to foreign-based organizations. Biotechnology patents account for the by far biggest share (26%). The next-largest fields are pharmaceuticals (13.7%), electrical devices/electrical engineering (9.6%) and organic, fine chemistry (8.2%). A specialization analysis confirms that, of the aforementioned areas, biotechnology and electrical devices - electrical engineering are the technological sectors in which university-related patents tend to be over-proportionally foreign-assigned. In these fields, relatively more patents have been assigned to foreign organizations than their overall share would suggest.

Flanders as well as Belgium are often characterized as an open, small economy in the center of Europe with a high share of patenting of foreign firms. The Flemish academic patents

underline this idea. A considerable number of them can be related with international corporations. So it is not surprising that about 23.2% of all Flemish academic patents are foreign-assigned. The most prominent cases are Zeneca (14 patents) and Alcatel (11).

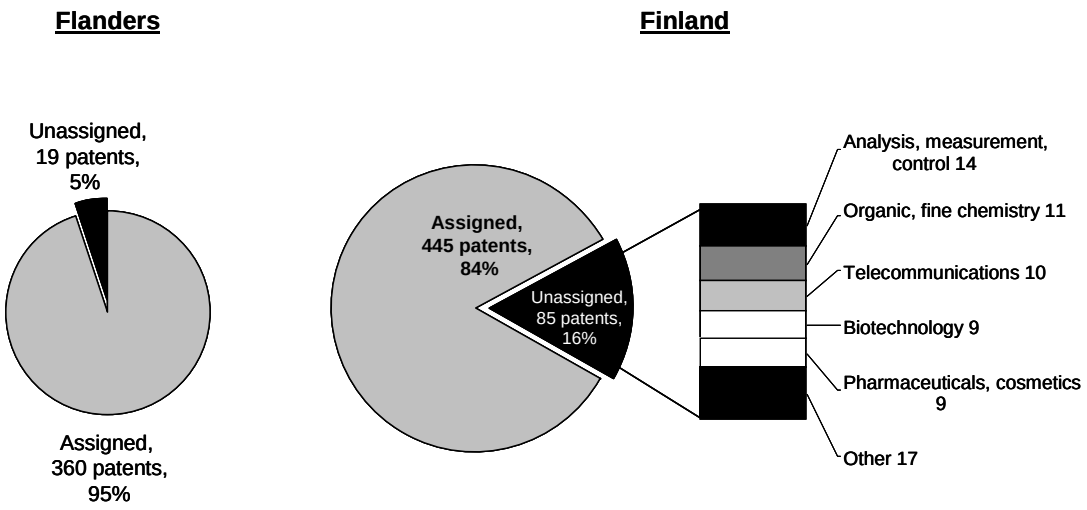
3.6 Individual Inventors as Assignees

There are clear differences between Finland and Flanders with respect to so-called unassigned patents, i.e., patents that are not assigned formally to anybody else than the individual inventors. While 16% of university-related patents are unassigned in Finland, only 5% are in Flanders. This is a finding that is most likely related to the different ways in which intellectual property is handled in universities. Figure 5 compares the shares of unassigned to assigned patents in Finland and Flanders and describes the technological association of the patents in more detail for the Finnish subset.

A total of 85, or 16%, of academic patents in ***Finland*** are neither assigned to a company nor to another organization. This does not mean individual inventors have not licensed the patent to one or several companies for further utilization. However, the data shows where individuals own the patents and a corporate user of the inventions is not immediately visible. Medical engineering, instruments and organic, fine chemistry are the fields that account for most of the unassigned patents. There are considerable variations between the universities. There are a small number of universities with a few patents where all of them were assigned to a company or other organization. In other cases, however, a considerable number of patents are still owned by individual inventors. In one instance, almost 43 percent of all patents that were associated with the university were not directly owned by a company (see *Meyer et al.*, 2003, for details). In three other cases, the rate was between a quarter to a third of all patents related to the respective universities. If one looks as to how unassigned university-related patents are related to all patents associated with the universities, one can observe that the share of unassigned patents in analysis/measurement /control, medical engineering, organic, fine chemistry is considerably greater than there shares in relation to all university-associated patents.

A far smaller number of patents are assigned to university researchers themselves in ***Flanders***. Not more than 19, or 5.01%, of all Flemish academic patents are assigned to individuals rather than other institutions. As for technological areas, unassigned patents occur four times in the field of medical engineering, three times in optics. Instruments, biotechnology and materials processing are the other areas that account for more than one patent that is not assigned to the university or any other organization. Again, this observation is not surprising if one considers the different intellectual property regulations that are in place in Flanders and Finland. Inventors, if they are employed can only obtain the patent right if the university or its transfer organization is not interested. However, one must be careful to infer less economic utilization of Finnish academic patents because of the higher share of unassigned patents as the inventors retain the right to commercialize their inventions.

Figure 5 Unassigned vis-à-vis assigned patents



3.7 Specialization

The differences in specialization raise the question to what extent some of the diverging observations can be explained by IP policy and regulation or by technological patterns. Telecommunications and instrument-related patents are the largest technological sectors in university-related patenting in *Finland*, with more than twelve percent respectively. Pharmaceuticals/ cosmetics and biotechnology account for about nine to ten percent of the university-related patents. Research elsewhere that followed up Finnish academic patents in more detail (*Meyer et al*., 2003b) suggests that patterns of collaborations vary with certain technology sectors. Not surprisingly the picture is different for the *Flemish* patents. Here, the focus is not on telecommunications but on organic chemistry and life-science related technological areas. Both fields account for about 16% of all patents.

4 Conclusions

This paper presents research that points to expected differences as well as similarities in academic patenting that may not have been anticipated necessarily. As for expected differences, the different assignee structures and the higher rate of unassigned patents in Finland are to be mentioned. Far more patents owned by universities and public assignees in Flanders than in Finland. Given the different intellectual property regimes, this is no surprise. Also in line with expectations is that the number of unassigned patents is higher in Finland than in Flanders. Also, here the IP regime is the background before which one needs to interpret this observation. In Finland, every researcher still has the right to patent and commercialize his or her research results. Not always this requires transferring the ownership of the patent to a corporation or other organization. Proprietor-entrepreneurs and start-up academic entrepreneurs may choose to keep the patents in their name and not the company's. While the data as it was presented in this paper allows us to infer about general modes of collaboration and transfer, it does not necessarily tell us much about the success or failure of commercialization attempts. Based on the data we have available we cannot make a judgment

as to which collaborative practice is more successful in terms of technology transfer. Here, only following up every single patent will give answers, a point that is taken up in the section on future research.

Finally with respect to differences, our study has illustrated a certain variance in Finland with respect to the within-university concentration of patents on key inventors. At least, the inventor distributions varied to a larger extent as we observed in the Flemish case. This raises the question to what extent the general IP system has affected this link. In the Finnish case, the universities may have more room to decide on which type of policy they pursue why in Flanders the overall regulation may further a similar type of behavior among researchers. On the other hand, Finnish universities differ substantially in their technological profiles. This may also relate to the differences in inventor concentrations.

A number of commonalities are also worthwhile mentioning. The inventive output was within the range of expectations for both systems. Finnish academics seem to be more inventive than their Flemish colleagues to a similar extent as the difference between Finland and Belgium in terms of overall patent productivity would suggest. Inventor and assignee concentrations are similar in both Finnish and Flemish cases. This seems to point to a more general pattern that patenting, or rather inventive activity, is concentrated on a small number on institutions. It remains to be seen to what extent the intensified promotion of patenting in European universities will encourage scientists in less active universities.

Suggestions for future research are related to the observation that the absolute level of university-related inventiveness does not seem to vary substantially between Flanders and Finland. Given that both Finland and Flanders are of approximately the same size, this result may not be surprising. On the other hand, the handling of intellectual property rights is different in both systems. Finnish university researchers own the rights to the results of their research whereas their Flemish colleagues transferred all the rights to the university. This raises the question whether or not the different IP systems influence the output level.

Another issue future research needs to address is how to measure the further utilization of university patents. Here, a combination of informetric and survey approaches may be helpful. This is an important issue especially if one seeks to compare inventive activity and its commercialization in countries or regions with different intellectual property regulations at university. The much higher rate of individual academic inventors owning ‘their’ patents raises in countries where researchers have the privilege to patent their research results themselves, such as Finland, and the high share of university and other public research organizations as owners of their researchers’ intellectual property, as it is the case in Flanders, raises the question to what extent have these patents been commercially exploited. Patent data alone cannot give an answer to these questions. However, a survey of inventors may shed light on this. To warrant comparability a common methodology in data collection should be applied. Without any further information, the analyst would find it difficult to make any judgments about ‘transfer efficiencies’ of the different systems. At last, a problem this first exploration was not able to address is the extent to which cooperative research and use of the patents through the industrial partner relates to university-based utilization and academic entrepreneurship. Here, future research needs to complement pure patent analyses with a hybrid approach that takes academic patents as the basis for

References

Carpenter, M.P.; Narin, F. (1983), Validation study: patent citations as indicators of science and foreign dependence. *World Patent Information*, 5 (3) 180-185.

Du Plessis, M.; M. Meyer (2003), *Academic patents in Flanders.* Steunpunt O&O Statistieken, KU Leuven, unpublished document.

Etzkowitz, H., A. Webster, P. Healey (eds.) (1998), *Capitalizing knowledge: new intersections of industry and academia*. SUNY Press: Albany, NY.

European Commission (2003), *Science, Technology and Innovation Indicators for the European Research Area* (STI-ERA).

Henderson, R.; A. Jaffe; M. Trajtenberg (1998), Universities as a source of commercial technology: a detailed analysis of university patenting, 1965-1988, *Review of Economics and Statistics*, 13, 119-127.

Kutinlahti, P. (2003) *SMEs and the new role of academic research. The country report: FINLAND.* VTT Technology Studies.

Meyer-Krahmer, F., U. Schmoch (1998), Science-based technologies: university-industry interactions in four fields. *Research Policy*, 27 (8) 835-851.

Meyer, M. (2003), Academic Patents as an indicator of useful research? A new approach to measure academic inventiveness? Paper presented at the International Science and Technology Indicators Conference, Karlsruhe, to be published in *Research Evaluation* (2003).

Meyer, M., T. Goloubeva, J.T. Utecht (2003), Free patent information as a resource for policy analysis. Forthcoming in *World Patent Information*.

Meyer, M., T. Goloubeva, J.T. Utecht (2003b), Towards hybrid Triple Helix indicators: A study of academic patents and a survey of academic inventors. Forthcoming in *Scientometrics*.

Meyer, M. (2002a), Tracing knowledge flows in innovation systems. *Scientometrics*, 54 (2) 193-212.

Meyer, M. (2000b), Tracing knowledge flows in innovation systems – An informetric perspective on future research on science-based innovation. *Economic Systems Research*, 14 (4) 323-343.

Schild, I. (1999), *A regional patent study to investigate inventive activity in East Gothia.* Tema-T Working Paper No.207, April 1999, Linköping University.

Smith, K. , A. Ekland, E. Iversen, A. Kaloudis, P. Patel, R. Narula, *Understanding Science, Technology and Innovation Indicators*, IDEA-Report 5/1998, Oslo: STEP Group.