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Respondent Report of the Knowledge Transfer Study (data for 2010)

European Knowledge Transfer Indicators Survey

Code of Practice Implementation Survey

Interviews with Firms Active in Four R&D Intensive Sectors

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Executive Summary

This report presents the results of three linked studies: a survey on the knowledge transfer activities of 430 European public research organisations (universities and research institutes), a survey of 100 research organisations on their intellectual property policies and practices, and interviews with managers from 60 R&D intensive companies on the incentives for and barriers against collaborating with public research organisations.

License income is highly concentrated, with the top 10% of universities and research institutes earning approximately 85% of all license income. The vast majority, 88.8%, of €346 million in reported license income is also from biomedical inventions.

Almost two-thirds of universities and research institutes report that their licensed technology resulted in at least one commercially successful product or process in the previous three years.

Universities obtain more invention disclosures, start ups, license agreements and research agreement per 1,000 staff than research institutes, but the latter outperform universities for patent applications, patent grants, and license income.

In 2010, European universities and research organisations outperformed their American colleagues for the amount of research expenditures required to produce one patent grant, start up and license agreement, but American universities and research organisations are better at producing invention disclosures, patent applications and license income. On average, license income in Europe equals 1.5% of the research expenditures by universities and research institutes, whereas in the United States license income equals 4% of research expenditures.

The number of knowledge transfer office staff has a substantial, positive effect on knowledge transfer outputs, including license income, after controlling for the size of the public research organisation, the policy for intellectual property ownership, and other factors. This provides a strong argument for supporting well-funded knowledge transfer offices.

Less than a third of knowledge transfer offices publish their affiliated institution's policies for intellectual property, licensing, and start ups. In addition, even though most offices monitor personnel changes, scientific competences, research projects, and inventions by their affiliated institution, less than half publish this information.

The most common incentive for research staff is a share of future license revenues, with the inventor receiving, on average, 41% of the income. Other incentives such as social rewards or additional funding for research are reported by less than half of the knowledge transfer offices.

The top three out of 10 objectives for knowledge transfer offices are to generate revenues for their institution (reported by 60%), generate possibilities for research collaboration (59%), and promote the diffusion of science and technology (45%).

Almost all knowledge transfer offices (83%) employ staff with an engineering or science degree. In addition, two-thirds of the offices employ staff with management or business degrees and 58% employ staff with law degrees.

The main motivation for R&D intensive firms to collaborate with public research organisations is to access competences and know-how. The main barrier is organisational factors, such as difficulties in negotiating contracts and managing projects. Incentives and barriers differ by the type of knowledge transfer mechanism.

Firm managers are very appreciative of informal contacts with research staff and are uneasy with the increasing use of formal knowledge transfer methods.

1.0 Introduction

This report provides some of the highlights of two surveys and a series of interviews, conducted during 2011, on the knowledge transfer activities of public research organisations. Public research organisations include universities and government-funded research institutes (the latter are henceforth referred to as 'research institutes'). The surveys were conducted as part of the project "Knowledge Transfer Study 2010-2012", funded by the Research and Innovation Directorate General of the European Commission.

The study has two short-term goals: collect internationally comparable data on the knowledge transfer activities of Europe's leading public research organisations and assess the uptake by knowledge transfer offices of the European Commission's Code of Practice for knowledge transfer activities. The longer term goal is to provide Knowledge Transfer Offices that serve public research organisations with information and analyses that they can use to improve their services.

Section 2 provides the results of the European Knowledge Transfer Indicators Survey (EKTIS). This is the largest survey to date on the knowledge transfer activities of European public research organisations, with results for up to 430 organisations in 32 European countries. The survey collected data on the characteristics of knowledge transfer offices and on nine outcome measures. After standardizing for research expenditures, European performance on six indicators is compared to that of the Association of University Technology Managers (AUTM) 2010 survey of American universities and research institutes.

Section 3 gives some of the highlights of a second survey on the intellectual property management practices of knowledge transfer offices. The survey compares actual practices with those proposed by the European Commission's 2008 "Code of Practice for universities and other public research organisations concerning the management of intellectual property in knowledge transfer activities" (see http://ec.europa.eu/invest-in-research/pdf/download_en/ip_recommendation.pdf).

Section 4 shifts from research into the activities of knowledge transfer offices that serve public research organisations to the perspective of company managers. Managers from sixty companies in R&D intensive sectors were interviewed about their views on the incentives and barriers to cooperation with public research organisations.

2.0 EKTIS survey

2.1 Introduction and Methodology

In the spring and summer of 2011, UNU-MERIT surveyed the Knowledge Transfer Offices of European public research organisations in order to obtain information on their knowledge transfer activities in 2010. The survey targeted the knowledge transfer offices of Europe's leading public research organisations. To be eligible for inclusion in the survey, the public research organisation had to be one of the top universities or institutes in terms of research expenditures or research staff in its country. Leading organizations were identified and surveyed in each of the 27 member states of the European Union and in the 12 Associated States.[1]

In total, 705 knowledge transfer offices were surveyed, ranging from 1 in small countries with only one or a few public research organisations to over 100 in the UK and Germany. With 402 replies, the response rate was 57%. This is similar to the 2010 Association of University Technology Managers survey in the United States, which obtained a response rate of 59.6%. Not all responses, however, were eligible: 64 respondents reported no knowledge transfer activities and a further seven public research organisations were not representative of 'leading' research institutes in their respective countries. This left 331 valid responses for analysis. Results for an additional 60 public research organisations were obtained from HEFCE for the UK and another 39 public research organisations in Spain were obtained from RedOTRI, giving a total of 430 responses. Figure 1 gives the number of valid responses by country.

The survey results provide the largest and most geographically diverse dataset to date on the knowledge transfer activities of European public research organisations, with valid responses from 26 of the 27 member states of the European Union and from six of the 12 Associated States.

This section provides some of the main results on the characteristics of the responding knowledge transfer offices and on the knowledge transfer performance of their affiliated public research organisations. Results are provided for six key and three supplementary knowledge transfer activities in 2010. The six key indicators are collected in most national surveys, including the AUTM survey for the United States and Canada. They include three measures of activities that do not necessarily result in knowledge transfer: the number of invention disclosures, the number of priority patent applications, and the number of technically-unique patent grants.[2] The second set of key indicators consists of measures that

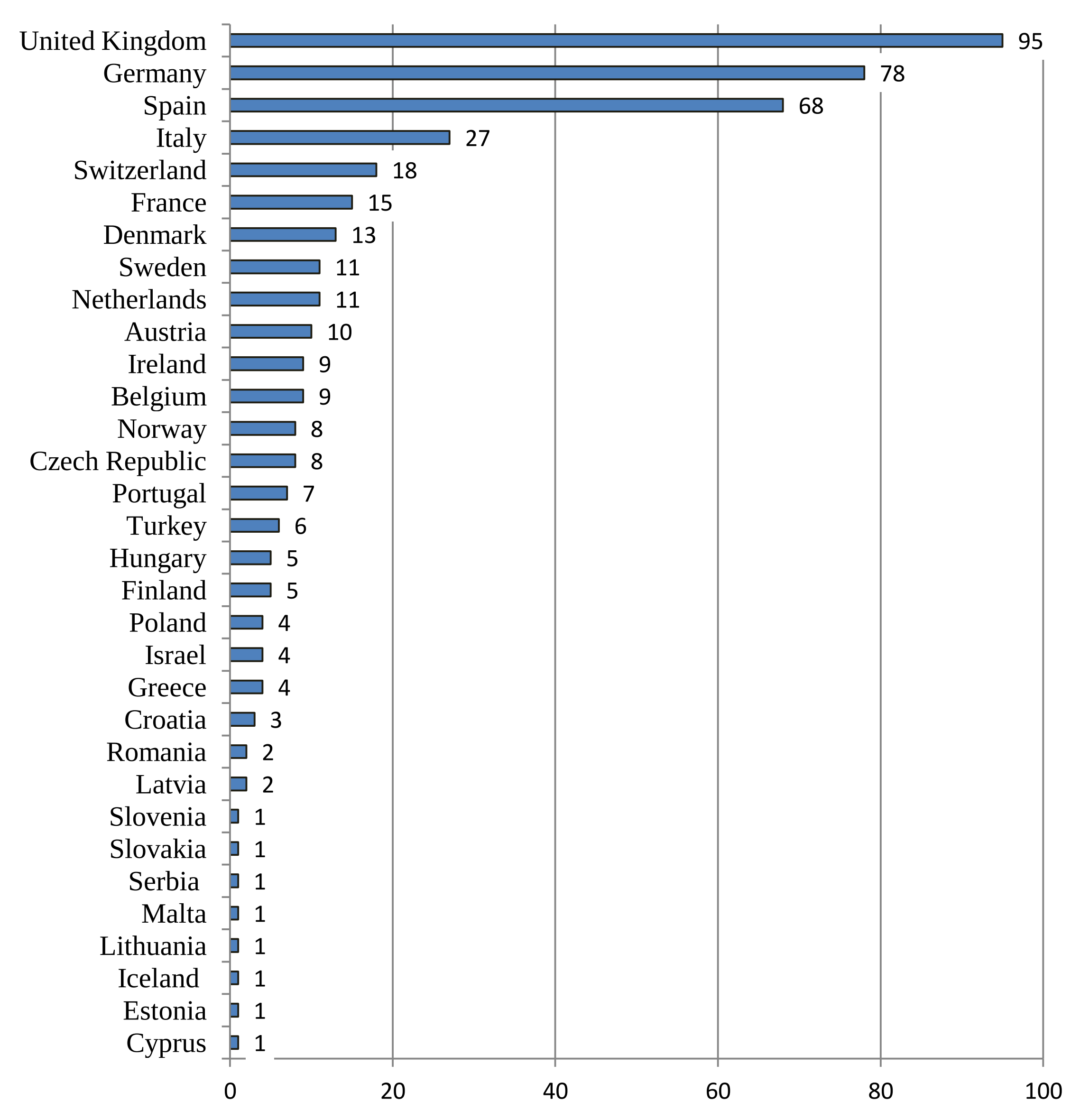
[1] These include the four EFTA members (Iceland, Liechtenstein, Norway and Switzerland) plus Albania, Bosnia-Herzegovina, Croatia, Israel, Macedonia, Montenegro, Serbia, and Turkey.

[2] The limitation to technically unique patents prevents double counting of the same invention in more than one jurisdiction.

involve knowledge transfer to firms: the number of start-ups[3], the number of licenses or option agreements with companies, and the amount of license income earned.

The three supplementary indicators are not collected in many national surveys. They include the number of R&D agreements between the affiliated institution and companies, the number of USPTO patent grants, and the number of successful start ups (the start up developed a product/process that is in use or sold on the market since 2005). In addition, the survey collected data on the types of licensees and license revenue by research area.

Figure 1. Number of valid respondents by country, 2010



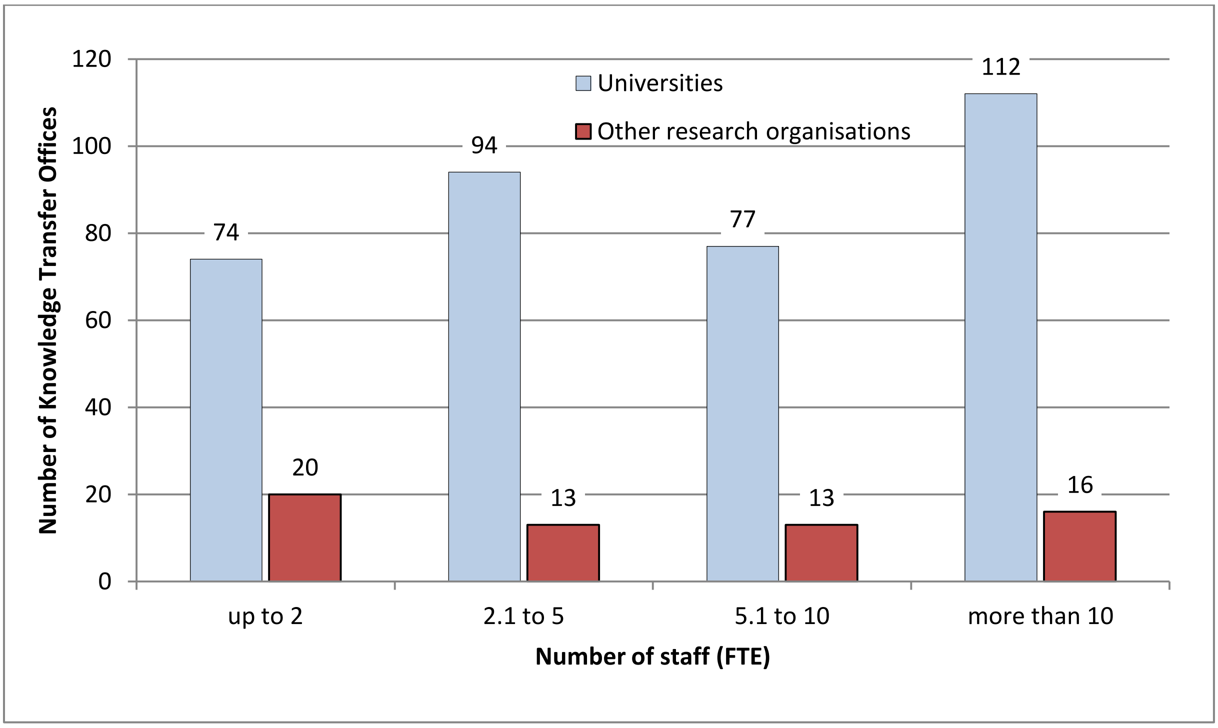
[3] A start-up is defined in the questionnaire as a company **specifically** established to exploit technology or know-how created by your institution.

2.2 Characteristics of European Knowledge Transfer Offices

Most of the 430 Knowledge Transfer Offices (KTOs) represent universities, were established after 2000, and have less than 10 office staff.

- 84.9% of the KTOs represent universities (of which 10% have a hospital) and 17.4% represent research institutes.
- 17.7% of KTOs were established before 1990, 22.9% between 1990 and 1999, and 59.4% after 2000.
- 20.8% of the KTOs representing universities have two or fewer staff, while 31.5% have 10 or more staff. Figure 2 gives the size distribution of KTOs.
- The average date of establishment is 1996 for KTOs representing universities and 1991 for KTOs representing research institutes.

Figure 2. Number of employees per Knowledge Transfer Office, 2010



At most public research organisations the ownership of intellectual property is held by the institution itself (28.9%) or shared between the institution and other parties (54.3%).

Data on research personnel are available for 414 public research organisations. The total number of reported research personnel is 805,980 full-time equivalents (FTE), of which 649,480 work at universities and 156,500 work at research institutes. Table 1 shows the distribution of research personnel. The average number of research personnel at universities in 2010 was 1,840 FTE and 2,566 FTE at research institutes. The higher average number of research staff at research institutes is due to a few very large national research institutes with over 2,500 researchers.

Table 1. Distribution of research personnel, 2010

	Universities		Research institutes	
	Number	Percent	Number	Percent
up to 499	73	20.7%	20	32.8%
500-1249	96	27.2%	30	49.2%
1250-2499	91	25.8%	1	1.6%
2500 or more	93	26.3%	10	16.4%
Total	353	100.0%	61	100.0%

Data on research expenditures are only available for 328 public research organizations. The total reported research expenditures amounted to approximately €32 billion, of which €21 billion was spent by universities and €11 billion by research institutes. Average research expenditures were €76 million at universities and €233 million at research institutes. Table 2 gives the distribution of research expenditures.

Table 2. Distribution of research expenditures (in million Euros), 2010

	Universities		Research institutes	
	Number	Percent	Number	Percent
up to 5 m	34	12.1%	3	6.4%
5 m - 14 m	55	19.6%	6	12.8%
15 m - 39 m	61	21.7%	7	14.9%
40 m - 79 m	56	19.9%	7	14.9%
80 m - 159 m	42	14.9%	12	25.5%
160 m or more	33	11.7%	12	25.5%
Total	281	100.0%	47	100.0%

2.3 Results for Knowledge Transfer Activities

Tables 3 and 4 summarize the results for the six key and three supplementary knowledge transfer indicators. The mean number of each type of outcome is not a performance measure, since the mean will vary depending on the number of researchers or research expenditures at each public research organisation. Standardized performance measures accounting for size differences are given in Section 2.4.

The least common output is USPTO patent grants, with 64.8% of universities and 48.8% of research institutes reporting no USPTO patents. The second least common output is start-ups, whith none reported by 35.1% of universities and 43.9% of research institutes. Almost all (92%) of the 1,128 reported start-ups were created by universities.

Table 3. Summary of key and supplementary indicators for universities, 2010

	Valid responses[1]	Mean	Total reported	Percent zero[2]
Invention disclosures	345	29.9	10,300	8.1%
Patent applications	352	14.4	5,061	11.6%
Patent grants	326	7.4	2,428	22.7%
Start-ups established	339	3.1	1,041	35.1%
Licenses executed	332	14.5	4,820	22.6%
License income (in Euros)	283	715,000	202,363,950	25.8%
R&D agreements	278	156.0	43,365	4.3%
USPTO patent grants	247	1.0	243	64.8%
Successful start-ups	258	7.4	1,917	15.9%

1: Number of KTOs reporting results for each performance measure (including zero outcomes).
2: Percent of respondents reporting 'zero' for each outcome. For example, 8.1% of 345 responding universities reported zero invention disclosures.

Table 4. Summary of key and supplementary indicators for research institutes, 2010

	Valid responses[1]	Mean	Total reported	Percent zero[2]
Invention disclosures	60	32.4	1,941	8.3%
Patent applications	62	27.4	1,698	16.1%
Patent grants	51	31.1	1,584	29.4%
Start-ups established	57	1.5	87	43.9%
Licenses executed	61	14.3	874	21.3%
License income (In Euros)	45	3,195,000	143,763,546	26.7%
R&D agreements	47	80.4	3,777	0.0%
USPTO patent grants	41	7.3	299	48.8%
Successful start-ups	38	3.9	149	23.7%

1: Number of KTOs reporting results for each performance measure (including zero outcomes).
2: Percent of respondents reporting 'zero' for each outcome. For example, 8.3% of 65 research institutes reported zero invention disclosures.

2.3.1 Licensing

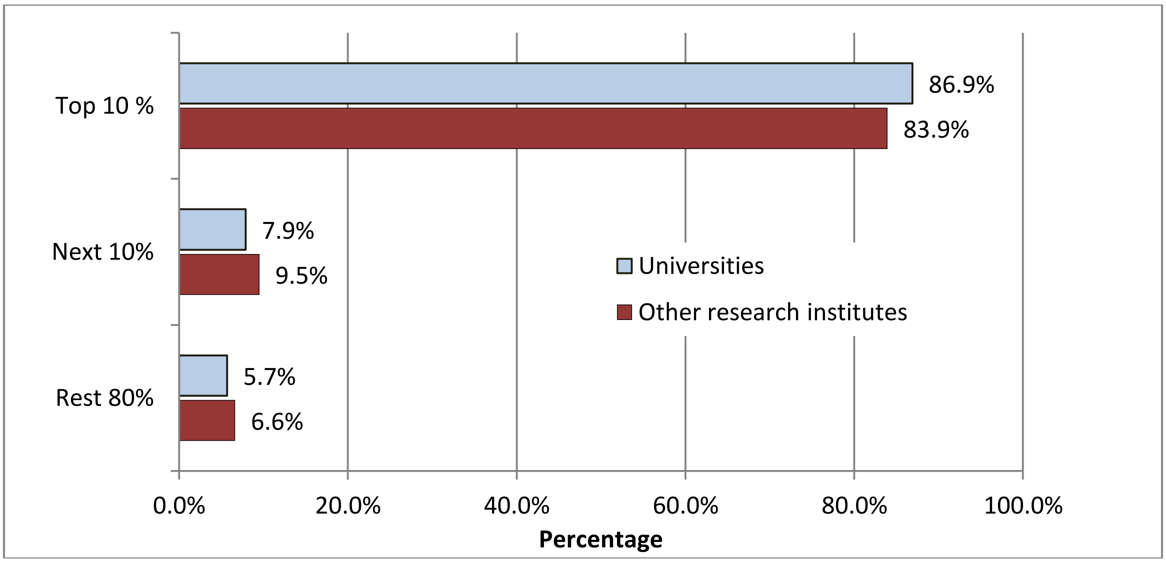
Total reported license income amounted to €346 million. Approximately €202 million (58.4%) was earned by universities and approximately €144 million (41.6%) by research institutes. Average license income was €715,000 at universities and €3,195,000 at research institutes. As shown in Table 5, the distribution of license income is highly skewed: 25.8% of the universities reported zero license income and 65% reported less than €100,000 of license income. A similar share of research institutes report zero license income, but a higher share report more than €100,000 in income (46.7% versus 22.6% for universities).

Table 5. Distribution of licence income, 2010

	Universities		Research institutes	
	Number	Percent	Number	Percent
Zero	73	25.8%	12	26.7%
€1 - € 19,999	47	16.6%	0	0.0%
€20,000 - €99,999	64	22.6%	7	15.6%
€100,000 - €249,999	35	12.4%	5	11.1%
€250,000 - €499,999	18	6.4%	4	8.9%
€500,000-€1,999,999	34	12.0%	8	17.8%
€2,000,000 or more	12	4.2%	9	20.0%
Total	283	100.0%	45	100.0%

Most of the license income is earned by a small percentage of public research organizations. As shown in Figure 3, the top 10% (28) of universities earn 86.9% of the total license income earned by all universities in the sample. The top 10% (5) of research institutes earn 83.9% of the total license income earned by these institutes.

Figure 3. Percentage of total licence income earned by top performers, 2010



Results for 283 universities and 45 research institutes.

Distribution of licences by type of licensee

The distribution of licenses is of interest as many national policies encourage licensing to either start-ups or to small firms with less than 250 employees. Table 6 gives the results for the distribution of licenses by the type of licensee. The distribution of licenses for start ups is similar for both universities (15.4%) and research institutes (13.8%). In contrast, research institutes give a higher share of licenses to small firms than universities (41.4% versus 30.1%) while universities issue a higher share of licenses to large firms (54.5% versus 44.8%). One possible explanation is that universities are more active in basic research that is further from the market. Commercialising this type of intellectual property could require large investments that are beyond the financial capabilities of many small firms.

Table 6. Distribution of licences by type of licensee, 2010

	Universities		Research institutes	
	Number	Percent	Number	Percent
Start up firms	338	15.4%	48	13.8%
Other firms with < 250 employees	659	30.1%	144	41.4%
Firms with 250+ employees	1,195	54.5%	156	44.8%
Total	2,192	100.0%	348	100.0%

Note: Results are limited to 127 respondents that reported licenses and answered in which category the license belongs.

Share of license revenue by research field

Respondents were asked if their affiliated institution applied for at least one patent from each of five research fields. This provides an indicator for the production of knowledge with a *potential* to earn license revenue. License revenue can also be earned without a patent, for instance through assigning know-how, copyright, or other forms of intellectual property, but at least one patent application in a research field suggests the production of commercially valuable inventions in this research area. Second, respondents were asked to estimate the distribution of license revenue by research field.

Table 7 gives the percent of public research organisations that report at least one patent application from each of five research fields. Almost half of all public research organisations (47.0%) report a patent application for inventions in the biomedical field, although a notably higher percentage of research organisations than universities (72.4% versus 46.6%) applied for at least one patent application in this field. The second most frequent research area (ignoring the 'other' category) is the ICT field (11.5%). Low or zero carbon energy technology ranks last, with only 2.2% of all patent applications from this research area.

Table 7. Share of public research organisations applying for at least one patent by research field, 2010

	Universities	Research organizations	Total
Biomedical	46.6%	72.4%	47.0%
ICT: Computers, communication equipment and software	11.4%	17.2%	11.5%
Nanotechnology and new materials	11.0%	10.3%	10.4%
Low or zero carbon energy technologies	2.5%	0.0%	2.2%
Other subject areas not listed above	28.4%	0.0%	29.0%
Total	100.0%	100.0%	100.0%

Results for 293 respondents that reported at least one patent application and answered the question on patent applications by research area. No results are available for HEFCE and RedOTRI respondents.

The distribution of patent application activity by research field, as shown in Table 7, does not translate into similar shares for license income. As shown in Table 8, licenses for biomedical knowledge account for *almost all* license income: 84.8% of income reported by universities and 91.4% of income reported by research institutes. Low and zero carbon energy technologies account for only 1.6% of the total license income. The dominance of the biomedical field suggests that public research organisations without health, biotechnology, or pharmaceutical research are likely to earn significantly less license income than those that conduct research in these fields.

Table 8. Share of licence revenue by research area (mean), 2010

	Universities	Research institutes	Total
Biomedical	84.8%	91.4%	88.8%
Computers, communication equipment and software (ICT)	4.6%	2.0%	3.0%
Nanotechnology and new materials	2.9%	0.7%	1.6%
Low/zero carbon energy technologies	0.6%	0.1%	0.1%
Other subject areas not listed above	7.1%	5.8%	5.8%
Total	100.0%	100.0%	100.0%

Results for 214 respondents that reported license revenue and answered the question on the distribution of revenues by research area. No results are available for HEFCE and RedOTRI respondents.

Commercially profitable outcomes of licensing

Almost two-thirds (63.6%) of respondents reported that licensed technology or knowledge had resulted in at least one commercially profitable product or process in the previous three years. There is little difference by the type of public research organisation, with successful outcomes reported for 62.2% of universities and 69.5% of research institutes.

2.4 Standardized Performance Indicators

On average, large public research organisations have more research staff and funding and therefore produce more knowledge outputs and earn more license revenue than small public research organisations. In order to compare results across countries or over time it is necessary to control for the size effect by producing standardized indicators. Two methods are used in this report: standardization per 1,000 research staff and standardization per unit of research expenditure. The research expenditure data are adjusted for purchasing power parities (PPP) in different countries. All results are limited to organisations that provided data on both the number of outputs and the standardization measure (either the number of research staff or research expenditures).

For comparisons within Europe, the indicators based on research staff are preferable because a higher number of respondents were able to provide data on research staff than on research expenditures. However, no data on the number of research staff are available for the AUTM results for the United States. Consequently, this report provides standardized performance indicators by research expenditures in order to be able to compare European and American performance.

2.4.1 Performance per 1,000 research staff

Table 9 gives standardized performance measures for 2010 per 1,000 research personnel. For example, universities produced on average 16.9 invention disclosures per 1,000 full-time equivalent (FTE) research staff in 2010. Universities earned, on average, €500,000 of license income per 1,000 researchers in 2010.

Table 9. Performance per 1,000 research staff, 2010

	Universities	Research institutes	*Total valid responses*[1]	Total
Invention disclosures	16.9	13.7	*361*	16.3
Patent applications	8.4	10.9	*351*	8.9
Patent grants	5.1	15.7	*279*	7.0
USTPO patent grants[2]	1.2	4.8	*107*	2.1
Start-ups established	2.2	0.8	*248*	1.9
Successful start-ups	4.5	2.2	*244*	4.2
License agreements	9.0	5.8	*295*	8.3
License income (million €)	0.5	1.4	*238*	0.7
Research agreements	94.1	36.2	*305*	84.8

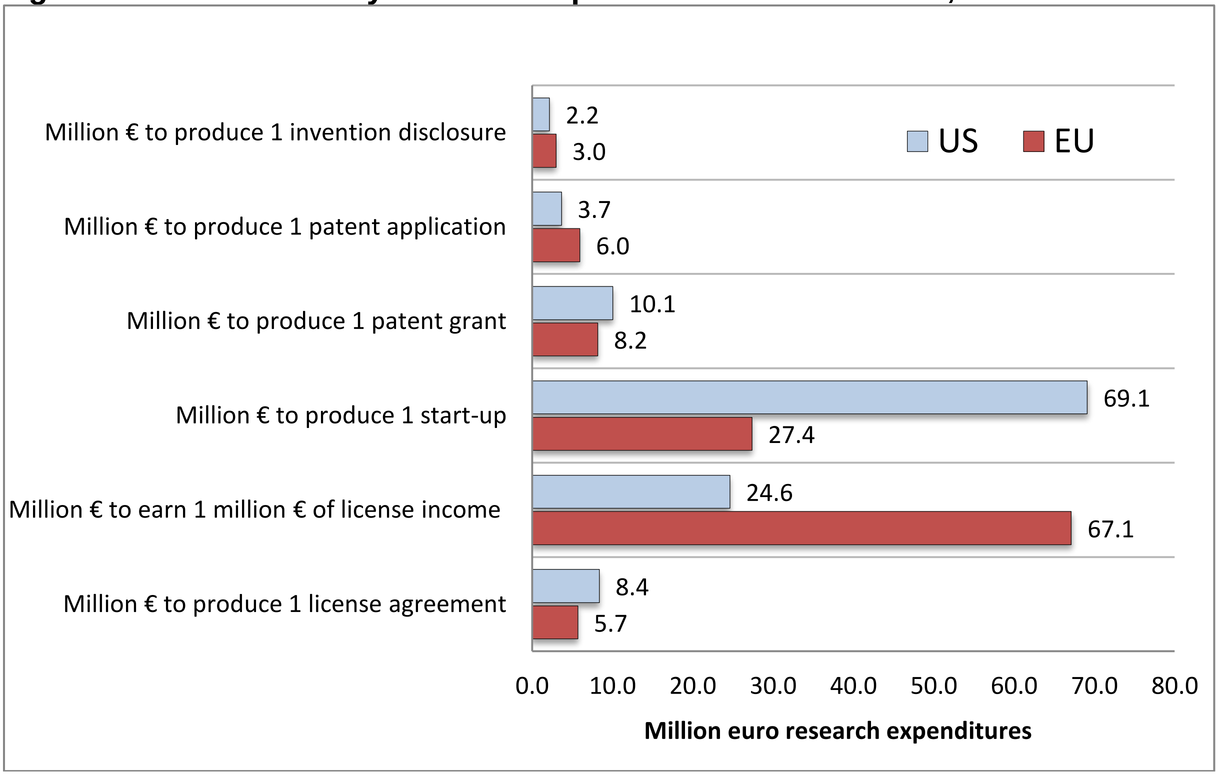
1: Limited to organisations that gave both outcome results (e.g.both invention disclosures and number of research staff).
2: Data from the UK HEFCE survey and the Spanish RedOTRI are not available for this variable. In addition, the question is only relevant for respondents that had at least one patent grant.

Universities outperform research institutes on invention disclosures, the number of start-ups, the number of successful start ups, license agreements and research agreements. Research institutes, however, have 2.5 more patent applications, 10.6 more patent grants, and €0.9 million more license income per 1000 researchers.

2.4.2 Performance comparisons with the United States

Figure 4 compares the 2010 performance of up to 296 European public research organizations with the 2010 performance of 183 American public research organisations, as surveyed by AUTM. The results give the cost, in million Euros, to produce 1 outcome. For example, European public research organisations spend, on average, €3.0 million to produce 1 invention disclosure, while American public research organisations spend €2.2 million for the same outcome. Consequently, American public research organisations are more efficient, producing one invention disclosure at lower cost. American public research organisations also perform better than European public research organisations for patent applications and license income. Conversely, European performance exceeds that of the US for patent grants, the number of start-ups and the number of license agreements.

Figure 4. Performance by research expenditures of EU and US, 2010



2.5 Role of Knowledge Transfer Offices in performance

Several factors could affect the output of public research organisations, including the experience of knowledge transfer office staff, the number of staff capable of evaluating the commercial opportunities of inventions, the number of researchers at the university or research institute, which will have a strong influence on the number of inventions; who owns the intellectual property (inventor ownership could result in a decrease in inventions handled by the knowledge transfer office), whether or not the organisation has an affiliated hospital (which could increase licensing revenue) and whether or not the organisation is a university or research institute. In order to control for multiple factors at the same time, regression analysis is used to investigate the effect of these six factors on the number of outputs. The main results are summarized in Table 10.

Table 10. Summary of regression results for knowledge transfer outputs

	Invention Disclosures[1]	Patent applic's[1]	Patent grants[1]	Start ups[1]	Licenses[1]	R&D agreements[1]	License income[2]
Number of researchers	+++	+++	+++	+++	++	+++	+++
Number of KT office staff (FTE)	+++	+++	+++	ns	+++	++	+++
KT office established before 2000[3]	ns	++	+++	++	---	ns	ns
IP owned by organisation (fully or with companies)[4]	ns	ns	ns	ns	+++	++	+++
Institute has a hospital[5]	++	ns	++	ns	ns	ns	+++
University[6]	ns	ns	ns	+++	ns	+++	---

1: Negative binomial regression models suitable for count data.

2: OLS regression model.

3: Comparison group is KTOs established from January 1st, 2000.

4: Comparison group is when IP is owned by the inventor or 'other' arrangements.

5: Comparison group is organisations without a hospital.

6: Comparison group is research institutes.

Ns = no significant effect, ++ = positive effect and $p < .05$; +++ = positive effect and $p < .001$; --- = negative effect and $p < .001$

As expected, the number of researchers has a strong positive effect on all outcomes. Intellectual property ownership by the public research organisation only has a positive effect on the number of licenses, R&D agreements and license income. This can be explained by a lack of control over licensing when the IP is owned by the inventor, resulting in a decline in licenses and license income for the organisation. The presence of a hospital increases patents and license income. This supports the earlier result that almost all license income is from biomedical research fields. Universities also have more start ups than research institutes and more research agreements, but less license revenue than research institutes. This is also found in the performance results presented in Table 9.

The experience of the knowledge transfer office, as estimated by its age, increases the number of patent applications, patent grants and start ups, but has no effect on invention disclosures, R&D agreements or license income. Older knowledge transfer offices have fewer license agreements, possibly because they are more cautious in entering into agreements that produce few benefits. The lack of a positive effect of experience on license income is, however, surprising. One possible cause is that younger knowledge transfer offices have invested more in business management skills and are therefore able to obtain equivalent amounts of revenue than older offices, but this question requires further research.

A very important result of the regression analyses is the importance of the number of knowledge transfer office staff, which has a substantial positive effect on all outcomes, except for start ups. This provides a strong argument for supporting well-funded knowledge transfer offices. The cause of the effect could be due to a diversity of skills in larger offices, more time to evaluate the commercial feasibility of inventions, or to outreach actions to identify inventions. The lack of an effect for start ups could be because they are driven by research staff seeking to exploit their own invention.

2.6 Conclusions

Most European Knowledge Transfer Offices (KTOs) are young, with 59.4% established after 2000. Furthermore, 48.1% have five or less employees (in full-time equivalents). These results suggest that many European KTOs are still developing experience and capabilities with managing the intellectual property produced by their affiliated university or research institute. Many KTOs could also be struggling with a lack of sufficient staff. Both of these factors could result in lower performance than expected, in terms of the number of patent applications, patent grants, start-ups, licenses, and license income.

The majority of licenses (54.5% for universities) are issued to large firms with 250 or more employees. Although national policies often encourage licensing to start-ups or small firms, this could be difficult to achieve if small firms lack the ability, interest, or finance to license intellectual property. Unfortunately, there are no data in this study that can be used to investigate why most licenses are issued to large firms.

Biomedical intellectual property is the largest generator of license revenue, accounting for 88.8% of the total reported license revenue for 2010, followed by ‘other subject areas’ at 6.3% and by ICT (3.0%). This suggests that the presence of a strong health, biotechnology or medical faculty at a university or research institute is likely to be a major factor in earning license revenue.

License income is highly concentrated, with the top 10% of universities accounting for 86.9% of all such income. This could partly be due to a lack of experience or staff at other universities, but additional factors could be equally or more important, such as large differences in the size of public research organisations (larger organisations are likely to produce more intellectual property and therefore earn more license income) or the presence of a hospital or biomedical research faculty.

License income provides only a small financial revenue stream to European public research organisations. Limited to respondents that reported both license income and research expenditures, total license income only accounted for 1.2% of research expenditures by universities, 2.1% of research expenditures by research institutes, and 1.5% of all research expenditures by European public research organisations. On this basis, license income is unlikely to account for a significant share of research expenditures. This suggests that the main function of a Knowledge Transfer Office should lie in the commercialisation of knowledge, whether or not this generates significant income for its associated institution. In this respect, the much higher rate of research agreements at universities (84.3 per 1,000 researchers) versus patent grants (4.3 per 1,000 researchers) indicates that research agreements are a very important channel for knowledge transfer, even though they may generate little license income. A further advantage of research agreements is that they can cause knowledge to flow in both directions, not only from public research organisations to firms, but also in the opposite direction.

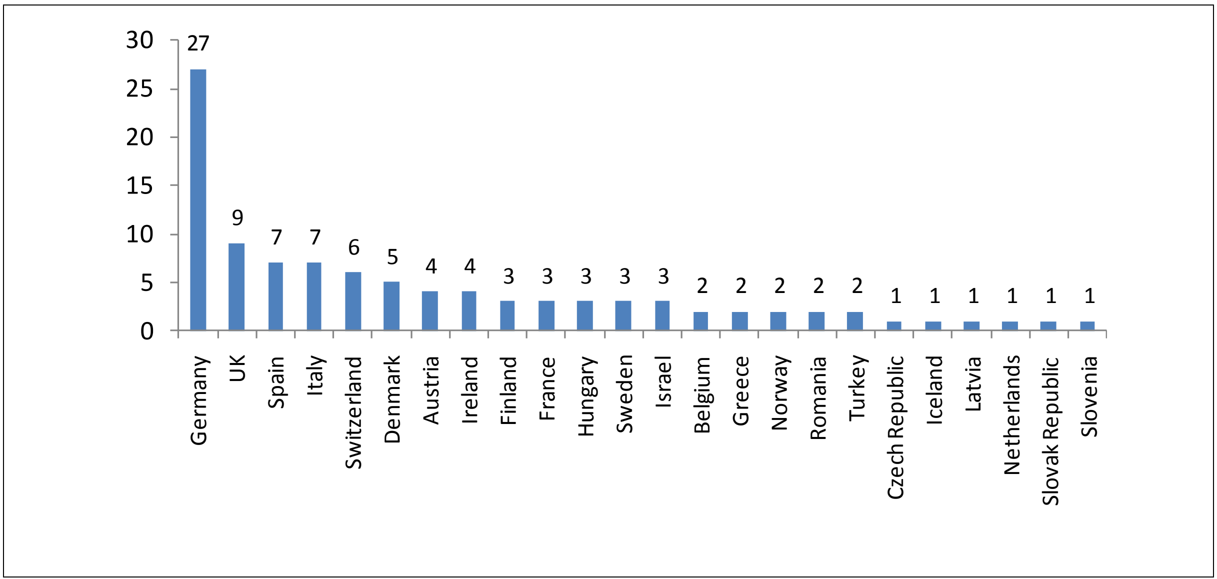
A comparison of performance between American and European public research organisations shows that the US outperforms Europe on invention disclosures, patent applications and particularly on license income. While European universities spend €83.3 million to generate €1 million in license income, American public research organisations only spend €24.4 million to generate €1 million in license income. This may be close to the upper bound of current best practice for license income, which suggests that license income could cover approximately 4% of total research expenditures. Europe outperforms the US on patent grants, the number of start-ups and on the number of research agreements. The better European performance on start-ups is encouraging, but the real issue is how many of these start-ups become financially sustainable.

3.0 Code of Practice Survey

3.1 Introduction and Methodology

The aim of this part of the study was to evaluate the principles and practices of intellectual property management and knowledge transfer used by European universities and research institutes. The online survey, conducted between June and September 2011, was sent to 202 knowledge transfer offices that had responded to the EKTIS survey (see section 2.1 above).[4] A total of 150 knowledge transfer offices activated the link to the online questionnaire (74.3%), but the results presented below are limited to 100 completed questionnaires. One or more responses were obtained from 24 European countries, with the largest number of respondents from Germany, the UK, Italy, Spain and Switzerland (see Figure 5).

Figure 5. Number of respondents by country to the code of practice survey



The questionnaire collected data on the implementation of 18 practices recommended by the European Commission's "*Code of Practice for universities and other public research organisations concerning the management of intellectual property in knowledge transfer activities*". This report provides results for four relevant topics: publication and dissemination of knowledge transfer data, staff incentives to protect inventions, objectives of intellectual property exploitation, and qualifications and training of knowledge transfer staff.

[4] The survey questionnaire was first tested by 16 knowledge transfer managers or experts. We would like to thank the following for their assistance: Christoph Adametz (Technical University Graz), Priv. Doz. Dr. Sara Matt-Leubner (University of Innsbruck), My Chung (University of Salzburg), An Van den Broecke (Ghent University), Dr. Pascale Redig (University of Antwerp), PD Dr. Joachim Aigner (Ludwig-Maximilians University Munich), Dr. Alexandros Papaderos (Technical University Munich), Dr. Hartmut Hillemanns (CERN), Dr. Bruno Dalle Carbonare (BDC Consulting), Robert Rudolph (Paul Scherrer Institute), Prof. Dr. Franz Baumberger (University of Applied Sciences Bern), Dr. Silke Meyns (ETH Zurich), Roy Kolkman, PhD (University of Twente), Dr. Koen Verhoef (The Netherlands Cancer Institute), Dorien Wellen (Radboud University Nijmegen) and David Bembo (Cardiff University).

3.2 Publication and Dissemination Policies

The survey asked if knowledge transfer offices publish their intellectual property policies and if they monitor the activities of their affiliated institution and if yes, if they publish this information so that it is available to interested parties outside of the public research organisation, such as company managers. Publication could help to increase visibility and attract the interest of potential research partners or licensees.

Table 11 provides the results for the existence and publication of the public research organisation's policies for intellectual property, licensing, and start ups. Most public research organisations have a policy for intellectual property (80%), but considerably fewer have a policy for licensing (45%) or for start ups (53%). Very few of these research organisations publish their policy in a way that makes it accessible to external parties. Only 33% publish their policy for intellectual property, 15% for start ups, and 6% for licensing. However, a very high percentage of the respondents do not know if the policy is publicly available, particularly for licensing and start up policies.

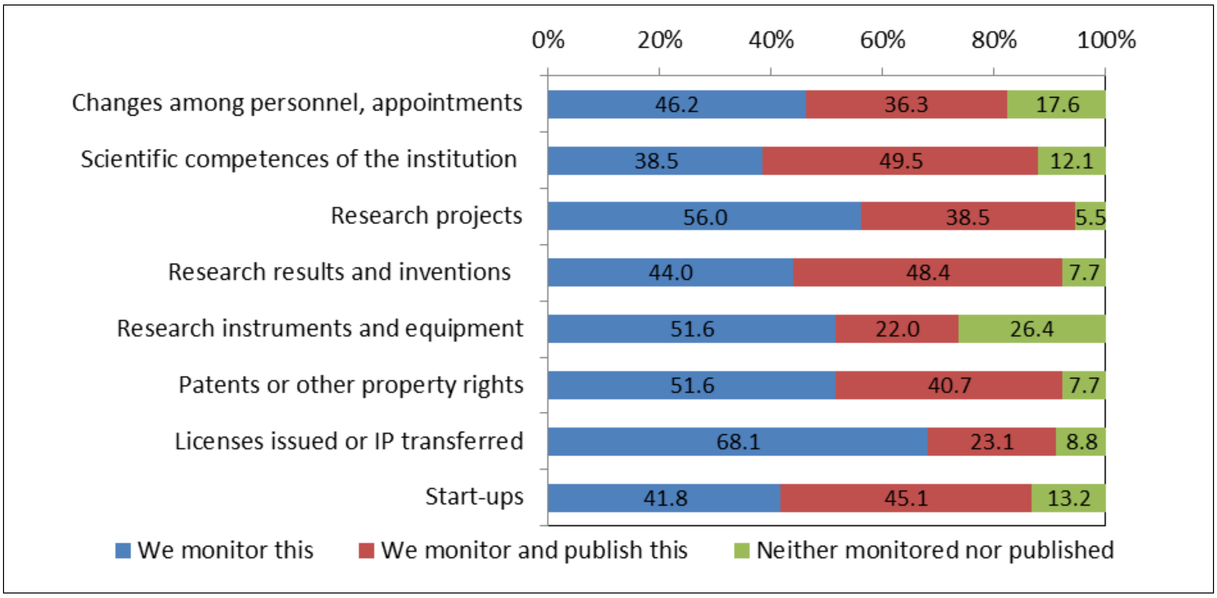
Table 11: Existence and publication of knowledge transfer policies (in % of responses)

	Intellectual property		Licensing		Start ups	
	Policy Exists	Policy Published[1]	Policy Exists	Policy Published[1]	Policy Exists	Policy Published[1]
Yes	80%	33%	45%	6%	53%	15%
No	6%	33%	30%	23%	27%	22%
No, but planned	14%	3%	21%	2%	18%	0%
Don't know	0%	31%	4%	69%	2%	63%
Total	100%	100%	100%	100%	100%	100%

1: Published both internally and externally.

Figure 6 provides results for the knowledge transfer office's awareness of relevant activities by their affiliated public research organisation. The majority of transfer offices monitor these activities. For example, 94.5% are aware of research projects and over 80% are aware of changes in personnel. However, the publication rate for these activities is much lower, with only 38.5% publishing information on research projects and 49.5% publishing information on the scientific competences of their institution.

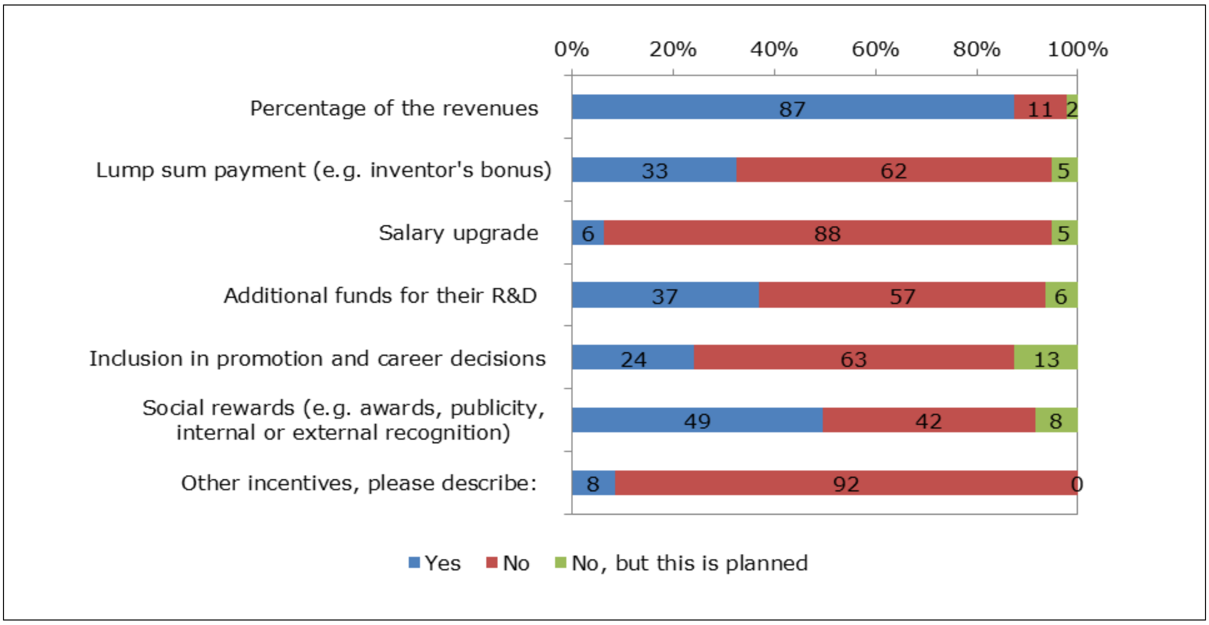
Figure 6. Percent of knowledge transfer offices that monitor and publish relevant information for knowledge transfer (N=91)



3.3 Incentives for intellectual property protection and exploitation

Incentives for research staff to protect their intellectual property should increase their willingness to disclose inventions with commercial potential. Incentives can include both monetary and non-monetary rewards. Figure 7 gives the percent of knowledge transfer offices that report the use of different incentives.

Figure 7. Percent of knowledge transfer offices that report incentives for protecting and exploiting intellectual property (N = 94)



All but one of 95 respondents who answered the question stated that their institution provides incentives to its employees and/or students to protect and exploit intellectual property. By far the most common incentive (reported by 84% of the respondents) is to offer inventors a percentage of future revenues. Other incentives are used less frequently: 47% report social rewards (such as awards, publicity, internal or external recognition), 35% report additional funds for R&D, 31% report lump sum payments such as an inventor's bonus, and 23% report that intellectual property is included in promotion and career decisions. Twelve percent of the institutions plan to include intellectual property in promotion and career decisions in the future. Overall, financial incentives dominate. This contrasts with the Commission’s Code of Practice, which emphasizes the use of non-financial incentives, such as promoting career progressions.

One reason for the importance of financial incentives is that the share of revenues going to the inventor has been shown in other research to increase license revenue.[5] Table 12 gives the distribution of revenues by recipient. On average, the inventor receives 40.7% of revenues, the inventor’s department or other units receives 18.6%, the public research organisation obtains 35.8%, and other entities receive 4.9%. Although the results are not shown, the inventor’s share tends to be lower in Western Europe and in research institutes, where the percentage of revenues kept by the institution is larger.

The distribution of revenues is similar to those found in previous studies. For example, in the fiscal year 1999 AUTM sample for the United States, 40% of revenues went to inventors and 26% to the inventors’ department (Markman, Gianiodis, Phan, & Balkin, 2004). In Italy, 44% went to inventors and 12.5% to inventors’ departments (Baldini, 2010 while in study of 52 Spanish universities 53% of revenues went to inventors (Caldera & Debande, 2010).

Table 12. Distribution of intellectual property revenues by beneficiary (N= 82)

	Inventors	Departments or other institutional units	Institution	Other
Mean	40.7	18.6	35.8	4.9
Median	33.3	20.0	33.3	0.0

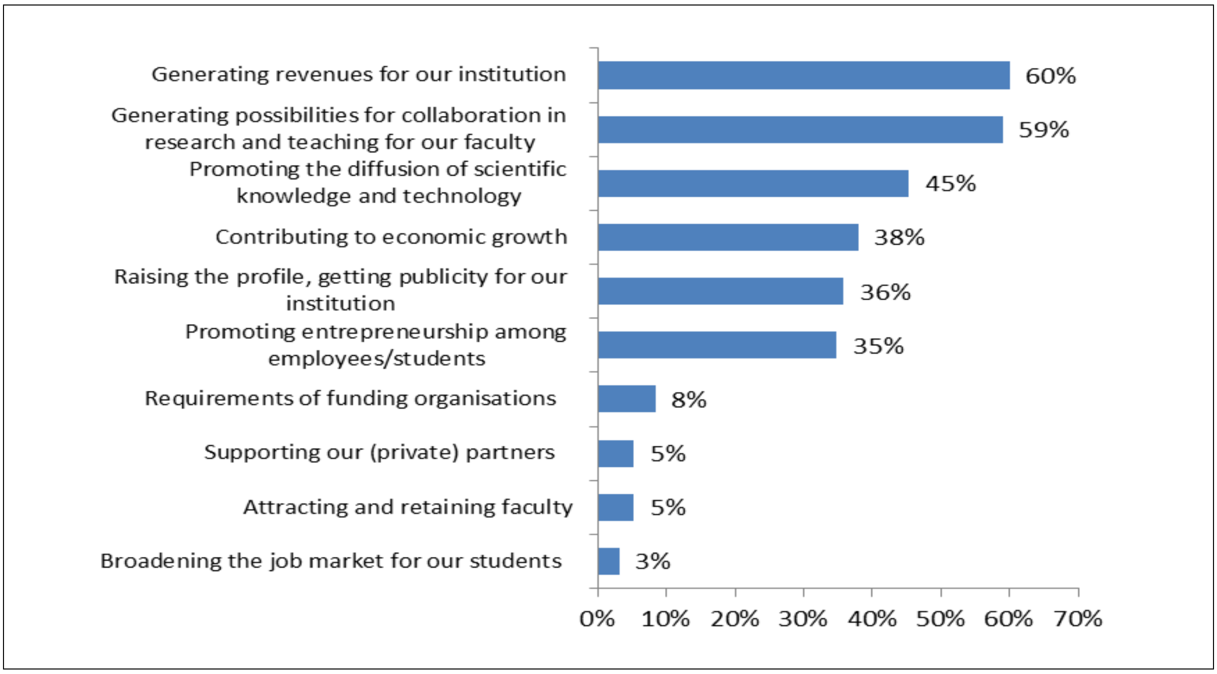
3.4 Objectives for intellectual property and exploitation policies

Respondents were asked to select the three most important objectives for their intellectual property and exploitation policies. The most frequent objectives, as shown in Figure 8, were generating revenues for their own institution (60%) and generating possibilities for collaboration in research and teaching (59%). The emphasis on earning revenue is not in line with the Commission’s Code of Practice, which gives greater importance to non-financial goals. Over a third of the respondents also mentioned promoting the diffusion of scientific

[5] The inventors’ share of the revenues is positively related to license income in US research universities (Lach & Schankerman, 2008) and Spanish universities (Caldera & Debande, 2010) and to the number of patent applications in Italian universities (Baldini, 2010).

knowledge and technology, contributing to economic growth, getting publicity, and promoting entrepreneurship as one of their most important objectives. The least cited objectives were supporting (private) partners, attracting and retaining faculty, and broadening the job market for students.

Figure 8. Most important objectives for intellectual property and exploitation policies, percent of respondents (N = 91)



The objectives of intellectual property and knowledge transfer policies are often not set independently by public research organisations, but in discussion with their funders and stakeholders. This could encourage strategies to maximize revenues (Mora, Detmer, & Vieira, 2010, pp. 86-88). Yet the high share of respondents that rank 'generating revenues' as one of their most important objectives is a surprise. In the 2008 CEMI survey of more than 200 universities from 15 European countries, generating revenues appeared on a par with attracting and retaining faculty and promoting national economic development. It was ranked as less important than the diffusion of knowledge and the promotion of local economic development (Conti & Gaulé, 2008). One explanation of the difference in results is that the present survey forced respondents to prioritise their objectives, which could have increased the importance attributed to generating revenues.

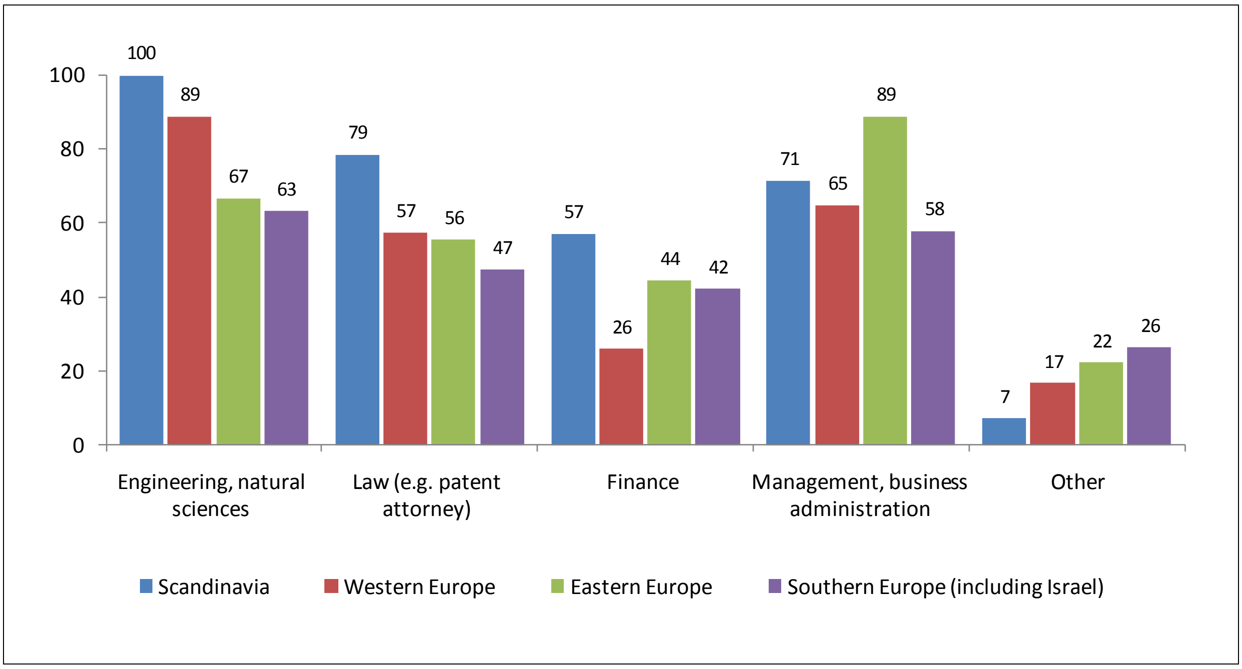
The importance of revenues is in contrast to their realised success: the EKTIS survey results discussed in Section 2 above shows that European research organisations earn approximately 15,000 Euros of licence income per Million Euros of research expenditure, or approximately 1.5% of research expenditures. The discrepancy between low licensing revenues and the high importance given to generating revenues requires further research. It could be due to governance issues, unrealistic aspirations, insufficient knowledge transfer staff (see Section 2.5) or a lack of commercially valuable inventions produced by the affiliated public research organisation.

3.5 Qualifications and training of knowledge transfer staff

More than four out of five responding knowledge transfer offices employ staff with a formal degree in engineering or natural science (83%). Two-thirds of the offices employ personnel with management or business administration degrees, 58% with formal law training, and 35% with finance degrees. Other degrees or experience include expertise in health sciences, knowledge management, media public relations, medicine, patent engineering and technology management (18%).

The composition of knowledge transfer staff varies by geographic location, as shown in Figure 9. For instance, compared to Scandinavia and Western Europe the percentage of offices with staff with degrees in science and/or engineering is considerably lower in Eastern and Southern Europe.[6] The relative importance of staff with a degree in finance, management or other disciplines is higher in the latter countries.

Figure 9. Percent of knowledge transfer offices by region with staff with different formal qualifications (N=96)



[6] The lower number and share of staff with a science or engineering degree also resulted in the CEMI survey (Conti & Gaulé, 2008).

4.0 Company Interviews

4.1 Introduction and Methodology

The purpose of this study was to explore the perception of company managers on the incentives and barriers to obtaining knowledge from European public sector organisations. The study is based on interviews with 60 companies based in 17 European countries.

The companies were selected on the basis of two criteria: 1) their sector of activity, with the focus on four R&D-intensive sectors (Biotechnology and Pharmaceuticals, Technology Hardware and Equipment, Software and Computer Services, Automobiles and Parts) and 2) high levels of R&D activity, as shown by their inclusion in the 2010 EU Industrial R&D Investment Scoreboard.[7] A sample of 120 companies was drawn – 24 from each of the four R&D intensive sectors and 24 from all other sectors combined, with 60 successful interviews completed (50% of the sample).[8].

Table 12 gives the distribution of interviewed companies by sector. The average participating company had R&D expenditures of €83 million and 7,000 employees in 2009. Only 8% of the interviewed firms were small or medium sized firms. Three quarters of the interviewed companies have R&D activities in other European countries and 50% are active in Europe and at least two other continents – mostly North America and East Asia.

Table 12. Interview respondents by industry

	N	Median R&D expenditures (€ million)[1]	Median R&D-intensity[1]	Median employees[1]	Share of small or medium sized firms
Biotechnology & pharma	13	131.7	16.2%	3875	15.4%
Automobiles & parts	11	106.9	5.4%	10031	0%
Software & computer Services	10	18.7	13.9%	1316	20%
Technology hardware & equip.	15	93.9	15.2%	2119	0%
Other industries	11	81.0	1.3%	28165	9.1%
Total	60	83.0	12.1%	7036	8.3%

1: 2009 data.

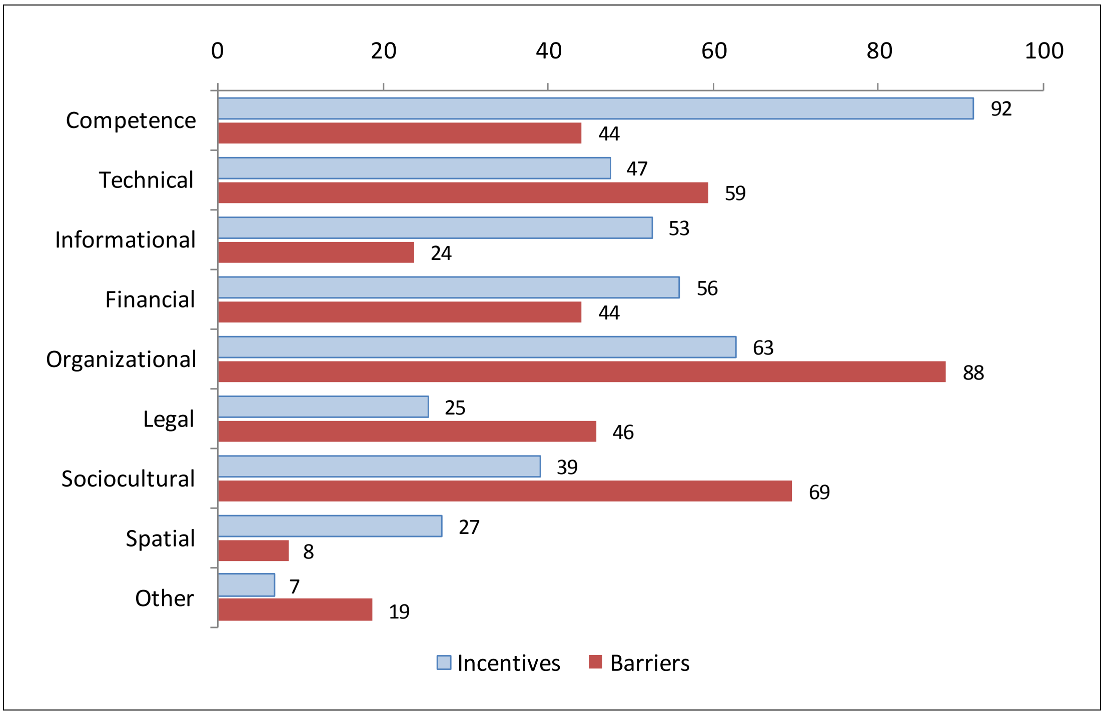
[7] See http://iri.jrc.es/research/scoreboard_2010.htm.

[8] Some of the participating firms agreed to be recognized by name. We gratefully acknowledge the contributions from: CIE Automotive, GKN, KTM Sportmotorcycle, MAHLE, Tofas, Piaggio & C. Spa plus 5 further firms from the automotive sector; Chiesi Farmaceutici SpA, Krka, Novartis, Novo Nordisk, Pharming Group, Recipharm and 7 further firms from the biotech/pharma sector; Amadeus IT Group, F-Secure, Indra Sistemas, Novabase, Readsoft, SAP, Systar, TXT e-solutions and 2 further firms from the software sector; ADVA Optical Networking, ARM, ASM International, ASML, austriamicrosystems, Ericsson, Infineon Technologies, Nokia, NXP Semiconductors, Option, STMicroelectronics, SUSS MicroTec and 3 further firms from the technology hardware sector; Isra, Plastic Logic, SNCF and 8 other firms from a variety of other sectors. The unnamed firms wished to remain anonymous.

4.2 Incentives and barriers to cooperation with public research organisations

Figure 10 gives the percentage of interviewees that cite each factor as an important incentive or barrier to research collaboration with public research organisations. By far the most important incentive for collaborating is access to competences, know-how, and the expertise of scientists and other staff employed by public research organisations. Also common are organizational, financial and information-related incentives. Technical, legal, spatial and sociocultural incentives were mentioned less frequently. However, the picture with regard to barriers is different. Organizational barriers were mentioned most frequently, followed by sociocultural and technical issues. Financial, competence-related and legal barriers are of medium significance; informational, spatial and other barriers are rarely viewed as important.

Figure 10. Incentives for and barriers to cooperation (N=59)



Incentives and barriers were also linked to each of four knowledge transfer mechanisms: 1) contract research, 2) collaborative R&D, 3) assignments or licensing of academic patents and 4) informal mechanisms. The patterns of incentives and barriers differ by the knowledge transfer mechanism, as summarized in Table 13. Overall, incentives and barriers were mentioned most frequently in connection with contract R&D and R&D collaborations.

1) *Contract R&D* is usually fully company-funded; consequently, financial incentives do not play a role. The most important incentive to engage in contract R&D is to access specific competences, which was mentioned by more than half of the interviewed companies. One-third of the companies identify organizational incentives, such as expanding on their internal research capacities, accessing specific infrastructure and instrumentation, shorter lead times and faster project realisation, or easier access to the generated intellectual property, particularly in comparison to collaborative research.

Table 13. Percent of interviewees that cite each factor as an incentive or barrier to using a specific knowledge transfer mechanism (N=59)

	Knowledge transfer mechanism							
	Contract R&D		R&D collaboration		Licensing academic patents		Informal mechanisms	
Factor	Incentive	Barrier	Incentive	Barrier	Incentive	Barrier	Incentive	Barrier
Competence	57.6	16.9	54.2	13.6	6.8	1.7	25.4	1.7
Technical	13.6	16.9	28.8	18.6	15.3	28.8	0.0	3.4
Informational	6.8	10.2	30.5	11.9	3.4	13.6	1.7	0.0
Financial	0.0	5.1	20.3	1.7	1.7	0.0	16.9	3.4
Organizational	37.3	42.4	20.3	55.9	0.0	16.9	1.7	3.4
Legal	1.7	5.1	8.5	15.3	1.7	1.7	0.0	0.0
Sociocultural	6.8	23.7	8.5	25.4	1.7	5.1	5.1	0.0
Spatial	1.7	0.0	1.7	0.0	0.0	0.0	8.5	1.7
Other	0.0	3.4	1.7	6.8	0.0	1.7	0.0	0.0

Organizational factors are the most commonly cited barrier to contract R&D, reported by 42.4% of the respondents. The problems mentioned by the respondents included complex and costly rules, difficult and time-consuming negotiations, lack of stability over time due to changes in staff and students, and the lack ofprofessional project management by the public research organisation.

Other barriers for contract R&D include different socio-cultural values and habits. These included adherence to goals and schedules and the interpretation of confidentiality and other agreements.

2) C*ollaborative R&D* was driven by a wide range of incentives, but particularly technical, informational and financial incentives. These include pooling competencies and approaches, accessing the specific know-how of scientists, obtaining technology and research results, risk reduction from governmental financial support or resource pooling, working within an established contractual framework, and the ability to get to know new partners and technologies.

Organizational issues were by far the most frequently mentioned barrier to collaborative R&D. Interviewees were particularly concerned about the difficulties of negotiating contracts (and agreeing on the various issues related to IP ownership and access rights), coordinating, steering and securing the benefits of participation in projects with multiple partners, cumbersome application procedures for funded projects, and long timeframes. Roughly one fourth of the interviewees also noted problems caused by differences between academic and corporate culture.

3) *Assignment or licensing of academic patents:* The single main driver for purchasing or licensing academic patents is to obtain rapid access to new technology. The main barrier was poor practical relevance and quality of academic patents, even for managers from the biotechnology and pharmaceutical industry where patents are widely used. For companies that

depend on strong intellectual property portfolios, the inability to control fully the patent management and licensing practice of public research organisations is an important reason for avoiding licences to academic patents. In addition, some of the previously mentioned organizational problems were also quoted in relation to patents.

4) *Informal mechanisms* are used as a source of new ideas, to get an overview of the academic state-of-the-art and new trends, to collect information when entering new fields, and to identify and recruit talented graduates. There are very few barriers. This mechanism is viewed as easy to set-up and maintain, requiring few resources (in comparison to formal knowledge transfer channels) and facilitates frequent and rich communication with nearby public research organisations.

Key characteristics such as company size, R&D-intensity, the geographical distribution of the the company's R&D and the degree of central R&D coordination seem to influence both incentives and barriers. Financial barriers were experienced by companies with less than 250 employees as well as by medium-sized companies with up to 1000 employees. Large companies with at least 15000 employees stress legal barriers and issues related to competence and expertise (in the public research organisation as well as the company itself).

All of the interviewed companies have informal contacts (through interns, issuing theses, informal exchanges) with public research organisations in their home country; 80% collaborate with public research organisations in other European countries and nearly 60% with North-American public research organisations, usually from the United States. Companies differ in their perception of the conditions in the United States and Europe for obtaining and commercialising knowledge and they stress different incentives and barriers. Whereas the interviewees highlighted barriers to obtaining and accessing intellectual property in the United States (consequences of the Bayh-Dole Act), they pointed to over-complex project arrangements and inflexible and impractical institutions in Europe. On the positive side, they stressed the high degree of professionalism of American knowledge transfer offices and the good opportunities for interaction and learning generated by European programmes to support research and innovation.

4.3 Dynamics of transfer and collaboration over time

The interviewees pointed to a broad set of different and partially opposing dynamics and changes to the incentives and barriers for knowledge transfer in Europe. These are due to changing governmental policies and laws, structures and actions of public research organisations, as well as the internal policies and strategies of the companies.

In respect to the internal policies of companies, several interviewees stressed that they select their public research partners more carefully than before. The selection criteria include expertise and a professional approach to managing intellectual property and contracts. A few interviewees mentioned that their company has implemented or tested concepts such as 'open innovation', which would require greater use of external research partners such as universities or research institutes.

The interviewees also noted that public research organisations were increasingly interested in knowledge transfer and collaboration. However, there were both positive changes leading to more efficient interactions and negative changes leading to a fall in interactions.

On the positive side, public sector organisations increasingly designed research to provide practical results and evaluated the commercial relevance of these results. Consequently, universities have become more orientated towards the private business sector. Another positive factor was that both companies and public research organisations had built up experience with working with each other. This had increased the awareness of both parties to the needs and constraints, regulations and implementation practices, and academic and economic requirements. This has contributed to making knowledge transfers easier.

On the negative side, approximately 40% of the interviewees noted that the increase in formal, contract-based cooperation had resulted in growing difficulties in establishing informal cooperation. The interviewees found that scientists at universities have become more cautious, aware of the potential commercial value of their work, and subject to stricter regulations and procedures when they engage with industry. This has led to longer and more complicated negotiations, higher costs, separate provisions for intellectual property in research contracts, and less access to intellectual property generated by public research organisations. These trends were a significant and growing barrier to commercializing public sector research results and were making Europe more similar to the United States.

From the interviews it is unclear whether this trend is still on-going or whether countermeasures such as the Commission's Code of Practice have started to change current practices. Some of the interviewee comments suggest an abating trend.

4.4 Conclusions

The results can be summarised in four key points:

First, public research organisations only make a limited contribution to private sector innovation. Though universities and research institutes try hard to develop commercially valuable discoveries, the willingness of companies to collaborate in these projects is reduced by difficulties in establishing, executing, and successfully concluding joint projects. All in all, the contribution of public research organisations to innovation is seen as limited.

Second, the current rules, practices and incentives don't serve the purpose of converting knowledge into socio-economic benefits very well. First and foremost, many interviewees strongly opposed the view that the socio-economic benefits of public research will be increased by policies that give universities and research institutes strong ownership of intellectual property and incentive schemes that provide public researchers with financial incentives for licensed research results. According to the interviewees, this strategy can result in a new set of problems:

- A misleading perception of the importance of public research organisations in innovation that results in more bureaucratic behaviour by university administrations and knowledge transfer offices, leading to long lasting contract negotiations, unrealistic price expectations for patents or licences, stalled project proposals and, in the end, less joint research and less valorisation of scientific knowledge and creation of socio-economic benefits.
- A reduced willingness of scientists to engage in an open and uncensored informal exchange of information with private enterprises and a waste of time in internal discussions and negotiations with their administrations.
- Less interest of private enterprises in cooperating with European scientists, increased search for expertise and technology from other sources or world areas, and strategies to bypass IP regulations and university bylaws.

Third, the increasing interest in knowledge transfer can have several useful outcomes for public research organisations. These include 1) commercialising research results and technologies, 2) demonstrating their role in society and justifying their public funding, 3) generating new research problems and questions of practical relevance, and 4) better preparing students for life after university.

Fourth, there is no "one-size-fits-all" approach to knowledge transfer. Interviewees from different industries lamented the fact that regulations, practices and knowledge transfer staff are biased by the extraordinary conditions and opportunities in the biotechnology and pharmaceuticals industry. They are not always familiar with the situation in other industries and able to adjust their approaches to exploitation and collaboration. This lengthens negotiations and complicates or even impedes commercialisation projects.

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