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University-industry knowledge and technology transfer in Switzerland: The university view

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University-Industry Knowledge and Technology Transfer in Switzerland: The University View*

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Abstract

This descriptive paper is part of a large project aiming at exploring the factors determining the propensity of Swiss science institutions to interact with private enterprises in Switzerland (universities and other research institution), i.e. to get involved in knowledge and technology transfer (KTT) activities. On the other hand, a second part of this project investigates the factors determining the propensity of Swiss private enterprises for KTT activities. We are especially interested in the different forms of this interaction, not only through joint research projects but also through training, mobility of academic personnel, jointly supervised master theses and PhDs, consulting and so on. Further, our study investigates the channels of KTT such as e.g. scientific publications, patents, spin-offs as well as the mediating institutions (e.g. Technology Transfer Offices, Commission for Technology and Innovation (KTI), Swiss Research Foundation (SNF)). We also discuss the relative importance of a series of motives for and impediments of KTT activities. Finally, we take also a look at the impact of KTT activities on the research orientation, on teaching and least but not last, the financial position of institutes co-orating with private enterprises.

1. Introduction

Experiences of the USA suggest that research of often publicly financed science institutions and commercialization of research results by private enterprises are compatible goals that reinforce each other, if both sides adopt a long-term perspective (as e.g. in aerospace, computers and telecommunication). However, there is accumulating evidence that many OECD countries are lagging behind in this aspect (see e.g. OECD 2002). Still, fears are also expressed in the literature that the tendency to commercialization of university research may cause universities to neglect basic research and teaching which are their main tasks, especially when commercialization revenues are substituted for public funds.¹ The interface between business firms and science institutions, especially universities has to be improved and as a consequence knowledge and technology transfer activities have to be intensified. Also in Switzerland it is asserted by many observers that the industry-science interface is far from being satisfactory (see e.g. Zinkl and Huber 2003). However, so far there does not exist a comprehensive study on extent, intensity, channels, content, goals, and impediments of KTT activities either on part of the science institutions or the private enterprises in Switzerland.

This paper is part of a large project aiming at exploring, at the one hand, the factors determining the propensity of Swiss science institutions to interact with private enterprises in Switzerland (universities and other research institution), i.e. to get involved in knowledge and technology transfer (KTT) activities in order to provide firms with scientific knowledge in research fields which are relevant for their own innovation activities. On the other hand, a second part of this project investigates the factors determining the propensity of Swiss private enterprises for KTT activities (see Arvanitis et al. 2005). We are especially interested in the different forms of this interaction, not only through joint research projects but also through training, mobility of academic personnel, jointly supervised master theses and PhDs, consulting and so on. Further, our study investigates the channels of KTT such as e.g. scientific publications, patents, spin-offs as well as the mediating institutions (e.g. Technology Transfer Offices, Commission for Technology and Innovation (KTI), Swiss Research Foundation (SNF)). We also discuss the relative importance of a series of motives for and impediments of KTT activities. Finally, we take also a look at the impact of KTT activities on the research orientation, on teaching and least but not last, the financial position of institutes co-operating with private enterprises. We hope that our analysis will cast some light

¹ For example, Rosenberg and Nelson (1994) argue for the maintenance of the “traditional” division of labour between university and industry also under the conditions of closer collaboration and more intensive exchange of knowledge taking place in many countries in the last years; Stephan (2001) discusses possible negative implications of university-industry technology transfer; in Nature (2001) was the opinion expressed that industry’s trend towards “closed science”, and closer ties to universities may endanger the intellectual independence of university basic research. Tijssen (2004) concludes in a study based on bibliometric data for the period 1996-2001 that companies “may well have redirected the goals of basic research and narrowed the focus towards strategic and applied research with shorter time-horizons.....”, a development which might also have influence their relationship to university.

on the industry-science interface problem addressed to above. This is to our knowledge the first Swiss institute-level study on this matter.²

2. Data

The data used in this study were collected in the course of a survey among Swiss enterprises using a questionnaire which included questions on the incidence of KTT activities among institutes or departments of Swiss science institutions (Federal Institutes of Technology (ETH), Federal Research Organizations, Universities and Universities of Applied Science – Fachhochschulen), forms, channels, motives and impediments of the KTT activities of Swiss science institutions as well on some basic institute or department characteristics such as the number of staff, categories of staff with regard to formal qualification (Diploma, Ph.D.) and function (technical, administrative), academic output (publications, academic degrees), technology output (patent applications, licenses, spin-offs), distribution of human resources over several academic tasks (basic and applied research, teaching, other tasks), and funds from outside the university.³ The survey was based on sample of all institutes and departments of the two federal technical universities (with the exception of the departments of humanities), the four federal research organization, the institutes and departments of engineering, natural sciences, mathematics and physics, medicine and economics and business administration of the ten canton universities as well as the seven regional universities of applied science, on the whole 630 single institutes and departments covering all scientific fields related to technology and science (see table 1 in the appendix for the composition of the sample). This sample has been constructed according to Internet information on the structure of each institution especially for this study. We received 241 completed questionnaires, i.e. 38.3% of the institutes and departments responded to our survey. However, the response rates vary significantly among the single universities (see column 3 in table 1). Thus, there is a tendency of the universities of applied sciences and the federal institutions to be over-represented, of the canton universities to be under-represented in our data set. Institutions from the French-speaking or Italian speaking part of the country have responded less frequently than those of the German-speaking part.

Finally, we tried to substitute for missing values in the variables due to item non-response by using the multiple imputations technique, but these attempts were not successful.

Table 2 shows the size distribution of the institutes or departments in our sample; the size class (10-19 institute employees) has the highest frequency (26.2% of responding institutes).

² In a recent study Vock et al. (2004) presented and discussed the results of a survey on codified forms of KTT (number of R&D projects in co-operation with firms, patents, licences); this survey was addressed to technology transfer offices at universities. Thierstein et al. (2002) investigated the spin-offs/start-ups of graduates of the universities of Eastern Switzerland, Berwert et al. (2002) the spin-offs/start-ups of Swiss technical universities.

³ Versions of the questionnaire in German, French and English are available in www.kof.ethz.ch.

Table 3 shows the distribution of the institutes by scientific field; Engineering is the most frequently reported scientific field (32.8% of all institutes).

3. Descriptive Analysis: Main Facts

Incidence of KTT Activities

According to the results in table 4 84.2% of the responding institutes or departments were involved in KTT activities with private enterprises in the period 2002-2004 or/and before 2002, 71.4% of respondents reported also KTT activities with foreign firms. This is a very high incidence of KTT activities also in international comparison, but it has to be considered with caution because of the rather low total response rate of 38.3%. We suppose that there exist some positive bias towards KTT in our sample. There are not significant differences among the various institutions (federal institutes of technology, federal research institutions, canton universities and regional universities of applied sciences) with respect to propensity to KTT activities. The comparably rather low figures for the Federal Institute of Technology in Lausanne and the University of Lausanne may be not be fully reliable because of the above-average low response rates of these two institutions (see table 1). As expected, universities of applied sciences show a higher propensity to KTT than the two other categories of science institutions but as already mentioned the differences are not large. KTT activities with foreign firms are also widespread, 94.1% of KTT active institutes co-operate with European firms, 48.2% with American and 18.2% with Japanese firms.

Forms of KTT Activities

Institutes reported their assessment of the importance of 19 single forms of KTT activities on a five-point Likert scale (1: “not important”; 5: “very important”) which were grouped together in the following five categories: informal informational activities, activities related to technical infrastructure, educational activities, research activities and consulting. By calculating the share of institutes that reported the values 4 or 5 for any single form or category of forms of KTT activities we could determine a ranking of the importance of various forms of KTT activities (see table 5). Educational activities were given the first priority (80.2% of all KTT active institutes), followed closely by informal informational activities (78.7%) and research activities (75.2%). Much less important were consulting (49.0%) and activities related to technical infrastructure (17.4%); the latter is quite understandable in view of the high endowment in technical equipment of Swiss science institutions. The two most important single educational activities were “contacts with former staff employed in the business sector” (46.5%) and “thesis projects in collaboration with firms” (42.1%). However, there are some remarkable differences among the various institutions: for the institutions of the ETH domain and the universities of applied sciences (see also table 6 for a ranking of the five main forms of KTT activities for every single

institution). For the institutions of the ETH domain and the universities of applied science have research activities a higher priority than informal informational activities. For universities are educational activities less important than informal informational activities. The access to joint technical infrastructure is relatively more important for the universities being confronted with more severe financial restrictions than the other two categories of institutions. Finally, among educational activities is the single activity “doctoral projects in collaboration with firms” quite important for the ETH domain (41.8%) and “thesis projects in collaboration with firms” (77.2%) for the universities of applied sciences.

Educational activities are a top priority for engineering institutes and institutes of economics and business administration, research for engineering, natural sciences and mathematics/ physics (see table 7).

Institute Funds from Outside Sources

According to the data in table 8 the mean share of funds from outside sources varied considerably among Swiss science institutions, namely between 28.5% and 69.0% (simple unweighted means). These differences almost disappear when we consider the three groups of institutions (federal, canton and regional institutions); the means of the means of the single institutes of amount to 40.7% for federal institutions, 41.2% for canton universities and 47.8% for universities of applied sciences. On the average 53.1% of outside funds of the universities of applied sciences come from the business sector. The corresponding shares for the federal institutions and the canton universities are 27.5% and 37.9% respectively. As expected the universities of applied sciences raised a considerably higher share of their funds from the business sector than the other two categories of more basic research oriented institutions.

Output of Science Institutions in Co-operation with the Business Sector

The mean share of diplomas in co-operation with private enterprises varied considerably among the various Swiss science institutions, namely between 0.0% and 80.5% (unweighted data; see table 9). The mean share of doctorates (without the universities of applied science which do not grant doctorates) varied between 3.5% and 33.8%. Universities of applied sciences have considerably higher shares of diplomas in co-operation with firms than universities and federal institutions. With respect to doctorates there are not large differences among the various institutions. A remarkably high share both of diplomas and doctorates has the University of St. Gallen, which is specialized in economics and business administration.

Table 10 contains data on university patenting, university licensing and university spin-offs. 34.45% of all institutes in our sample reported patent applications in the period 2002-2004. Only 12.2% of all institutes reported licenses in the same period, 21.7% helped spin-offs to start operations. The shares of institutes with patent applications are rather evenly distributed among the various science institutions. Considerably more than half of patents of the universities of applied sciences and the universities are done in co-operation with private

enterprises. In the federal institutions have less than half of patents achieved in co-operation with firms. Licensing is more frequent among federal institutions than between the other two groups of institutions. Finally, spin-offs are on average more often initiated in the federal institutions and the universities of applied sciences than in the canton universities.

Transfer-mediating Institutions, Transfer Media

What kind of transfer-mediating institutions is more relevant for institutes pursuing KTT activities? Table 11 contains information on the importance as reported by institutes of technology transfer offices of the single institutions, the government innovation agency KTI (applied research), the Swiss Research Foundation (SNF; basic research), the EU Framework Programmes and other EU programmes (mostly applied research). 27.7% of institutes assessed the KTI to be quite important for KTT activities. 20.6% reported the EU Framework Programmes (12.9% other EU programmes), 19.6% the SNF as very important mediating institutions. Only 16.8% of institutes found transfer offices to be relevant mediating institutions.

What type of transfer media is more often used? Knowledge transfer takes place primarily through scientific publications (60% of KTT active institutes; see table 12). Patents, licenses and spin-offs are found to be important transfer media by only 21.0%, 16.7% and 17.6% of KTT active institutes respectively.

Motives for KTT activities

Institutes reported their assessments for 24 single goals or motives for KTT activities on a five-point Likert scale (1: “not important”; 5: “very important”) which were grouped together in the following five categories: financial motives, access to human capital (“tacit knowledge”), access to business sector research findings (“codified knowledge”), access to business sector R&D facilities and institutional and organizational motives. By calculating the share of institutes that reported the values 4 or 5 for any single motive or category of motives for KTT activities we could determine a ranking of the importance of various groups of motives (see table 13).

Financial motives are the most often reported motives for KTT activities with private enterprises (about 90% of KTT active institutes). About 75% found the “access to human capital (tacit knowledge)” and institutional and organizational motives respectively as very important. Only approximately 45% assessed “access to business sector research findings” and “access to business sector R&D facilities” as highly relevant. This ranking of the importance of the five motive categories is valid for all three groups of institutions (ETH domain, universities and universities of applied sciences). Almost the same pattern can be found also for most of the single institutions (see table 14) and for engineering institutes and institutes of economics and business administration (see table 15). In medicine and mathematics and physics are the motives “access to codified knowledge” and “access to R&D

facilities” not relevant. For natural sciences is “access to codified knowledge the least important group of motives for KTT activities.

Impediments of KTT activities

Institutes reported their assessments for 26 single obstacles of KTT activities on a five-point Likert scale (1: “not important”; 5: “very important”) which were grouped together in the following six categories: lack of information, problems in the areas of teaching and basic research, deficiencies of potential industry partners, deficiencies of science institutions themselves, cost, risks and uncertainty, institutional or organizational obstacles. By calculating the share of institutes that reported the values 4 or 5 for any single obstacle or category of obstacles of KTT activities we could determine a ranking of the importance of various groups of obstacles (see table 16, also table 17 for the results by science institution).

Organizational or institutional problems seem to be the most frequently reported obstacle of KTT activities (60.4% of KTT active institutes). This kind of problems is of similar concern for institutes of all three groups of institutions. “resource-intensive administrative and approval procedures, legal restrictions” are the most important single obstacle for the total of KTT active institutes (38.1%). Rather unexpected, for universities of applied sciences they are the most important single obstacle in all categories (46.4%). Organizational or institutional are not so relevant for die institutes of the ETH domain (26.9%).

Problems related to a (possible) neglect of teaching and/or basic science (53.6%) constitute the second most important obstacle category. “Teaching requires too much time” is the most important single big concern in this category (33.0% of KTT active institutes), particularly for universities (40.0%) and universities for applied universities (42.3%); this kind of problems is of no relevance for the institutes of the ETH domain (11.5%). Presumably, these divergences reflect differences with respect to teaching obligations among the various types of institutions.

Costs, risks and uncertainty with respect to co-operation results (48.7%), deficiencies on part of the potential industry partners (47.2%) and informational problems (46.5%) constitute the third most important group of KTT obstacles. The most frequently reported single obstacles in these categories are the “too low level of R&D budgets of potential business partners” (42.1%) and the “lack of interest in scientific projects on part of potential industry partners” (41.6%), The former seems to be a problem particularly for the institutes of the ETH domain (53.8%) and the universities of applied sciences (60.7%) but not for the “classical” universities (23.6%); the latter seems to be a severe obstacle of KTT activities especially for the institutes of the ETH domain (50.0%).

It is quite remarkable that the group of obstacles “deficiencies on part of the institutes themselves” (40.4%) is the least important category of obstacles according to institutes’ own assessment.

The lack of information on industry R&D and organizational or institutional problems seem to be important KTT obstacles almost at the same extent for all five scientific fields (see table 18). There are substantial differences of ranking of the importance of the other three categories of obstacles. Neglect of teaching and basic research are more relevant in economics/business administration but less relevant in mathematics and physics. Deficiencies on part of business partners are more important for mathematics and physics but less so for medicine. Finally, deficiencies of the institutes themselves are a severe obstacle particularly for natural sciences, but of much less importance for engineering.

Impact of KTT Activities

KTT active institutes were asked to assess the impact of their KTT activities with respect to a) financial matters, b) their research orientation, c) teaching and other education activities and d) their scientific reputation. For all three groups of institutions a comparably high share of institutes asserted a positive financial result leading primarily to additional resources for research (73.7% to 83.3% of KTT active institutes; see table 19), less so to additional resources for technical facilities (28.1% to 43.7%). 54.5% of the university institutes and 62.3% of the institutes of the ETH domain reported that KTT activities did not cause any change of their research orientation. 46.6% of the university institutes and 39.6% of institute of the ETH domain asserted that KTT activities led to more applied research. The institutes of applied sciences experienced the strongest push towards applied research (73.7% of KTT active institutes), which quite understandable in view of the re-orientation of the mission of this type of institutions from teaching towards more applied research in the last years. This explains also why 23.2% of these the institutes reported at the same time that as consequence of KTT activities less time for teaching and student support were available. KTT activities also helped to provide education more geared towards practice for 83.9% of institutes of applied science universities and 63.0% of institutes of the ETH domain but only 42.5% of the university institutes. Finally, scientific reputation was not at all damaged, as some European academics fear that in case of intensive KTT activities could happen. On the contrary, 86.0% of respondents of the universities of the applied sciences, 66.0% of those of the ETH domain and 54.7% of the university respondents reported that KTT activities led to a better reputation of their institute. On the whole, the overall impact of KTT activities seems to be positive.

4. Conclusions and Summary

The most important findings of the study refer to the overall propensity to KTT activities with private enterprises. Institutes belonging to the federal institutes of technology (ETH) are more inclined to KTT activities than institutes of the other three groups of institutions. In accordance to expectations, institutes of economics and business administration, natural sciences, engineering and medicine, ranking as above presented, are stronger involved in KTT activities than institutes of mathematics and physics. Financial motives seem to be the most

frequently reported category of motives for KTT activities. Institutes not involved in KTT activities were seriously impeded from undertaking such activities by a series of single obstacles that primarily reflect the (legitimate) fears of academics of neglecting their main task or reduce the quality of their work in case they get involved in KTT activities.

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Table 1: Composition of Net Sample, Response Sample and Response Rates

Institutions	<i>Net Sample</i> Number of Institutes or Departments	<i>Responses</i> Number of Institutes or Departments	<i>Response Rate</i> (%)
<i>ETH Domain</i>			
Swiss Federal Institute of Zurich	87	45	51.7
Swiss Federal Institute of Technology Lausanne	31	12	38.7
Federal Research Institutions (*)	11	11	100.0
<i>University of</i>			
Basle	32	11	34.4
Berne	84	33	39.3
Fribourg	17	5	29.4
Geneva	46	15	32.6
Italian Switzerland	9	2	22.2
Lausanne	69	12	17.4
Neuchâtel	22	6	27.3
St. Gallen	21	8	38.1
Zurich	74	22	29.7
<i>University of Applied Sciences of</i>			
Berne	13	9	69.2
Central Switzerland	10	5	50.0
Eastern Switzerland	36	14	38.9
Italian Switzerland	7	2	28.6
North-western Switzerland	27	17	63.0
Western Switzerland	12	4	33.3
Zurich	22	8	36.4
Total	630	241	38.3

(*): Paul-Scherrer Institute (PSI); EAWAG; EMPA; WSL.

Table 2: Institute Size

Number of employees (*)	N	Percentage of institutes
up to 9 employees	36	14.9
10-19 employees	63	26.2
20-39 employees	47	19.5
40-99 employees	54	22.4
100 and more employees	41	17.0
Total	241	100.0

(*): Institute employees: professors, academic staff with doctorate and 'habilitation', academic staff without doctorate, technical staff with university degree, staff carrying out other supporting and administrative functions in full-time equivalents

Table 3: Institutes by Scientific Field

Scientific field	N	Percentage institutes
Economics, Business Administration	47	19.5
Engineering	79	32.8
Mathematics, Physics	21	8.7
Medicine	62	25.7
Natural Sciences	32	13.3
Total	241	100.0

Table 4: Incidence of Knowledge and Technology Transfer (KTT) Activities of Swiss Science Institutions (percentage of institutes)

Institutions	N	KTT (*)	Foreign KTT
<i>ETH Domain</i>			
Swiss Federal Institute of Zurich	45	88.9	77.8
Swiss Federal Institute of Technology Lausanne	12	58.3	58.3
Federal Research Institutions (**)	11	72.7	63.6
<i>University of</i>			
Basle	11	81.8	81.8
Berne	33	84.8	78.8
Fribourg	5	80.0	60.0
Geneva	15	73.3	46.7
Italian Switzerland	2	50.0	100.0
Lausanne	12	66.7	58.3
Neuchâtel	6	83.3	100.0
St. Gallen	8	87.5	75.0
Zurich	22	81.8	77.3
<i>University of Applied Sciences of</i>			
Berne	9	88.9	55.6
Central Switzerland	5	100.0	20.0
Eastern Switzerland	14	92.9	64.3
Italian Switzerland	2	100.0	50.0
North-western Switzerland	17	100.0	70.6
Western Switzerland	4	100.0	100.0
Zurich	8	100.0	75.0
Total	241	84.2	71.4

(*) KTT: knowledge and technology transfer in the period 2002-2004 and/or in the period before 2002; (**): Paul-Scherrer Institute (PSI); EAWAG; EMPA; WSL.

Table 5: Forms of Knowledge and Technology Transfer Activities of Swiss Science Institutions by Type of Science Institutions (percentage of institutes with values 4 or 5 for a single form or any single form belonging to the same main group of forms of KTT activities)

Forms of KTT activities	ETH Domain	Universities	Universities of Applied Sciences	Total
<i>Informal contacts, personal network of contacts</i> <i>N</i>	74.5 55	78.9 90	82.5 57	78.7 202
Informal contacts (phone, email)	65.5	63.3	75.4	67.3
Conferences, exhibitions, workshops	29.1	37.8	38.6	35.6
Academic publications of business sector	21.8	25.6	31.6	26.2
<i>Technical facilities</i> <i>N</i>	12.7 55	22.5 89	14.0 57	17.4 201
Joint laboratories	5.5	10.1	10.5	9.0
Technical facilities or research centres at business sector R&D departments	9.1	19.1	5.3	12.4
<i>Training, further education, staff mobility</i> <i>N</i>	80.0 55	71.1 90	94.7 57	80.2 202
Contacts with graduates employed in the business sector	52.7	46.7	59.6	52.0
Contacts with former staff employed in the business sector	56.4	44.4	40.4	46.5
Student participation in corporate R&D projects	30.9	18.9	45.6	29.7
Thesis projects in collaboration with firms	40.0	21.1	77.2	42.1
Doctoral projects in collaboration with firms	41.8	25.6	5.3	24.3
Engagement of business sector scientists in university research projects	27.3	27.8	33.3	29.2
Joint teaching courses or programmes	7.3	27.8	21.1	20.3
Teaching assignments for business sector staff	10.9	21.1	45.6	25.2
Attendance of courses or programmes of institute by business sector scientists	40.0	20.0	47.4	33.2
<i>Research</i> <i>N</i>	78.2 55	66.7 90	86.0 57	75.2 202
Research projects in collaboration	67.3	56.7	82.5	66.8
Longer-term research contracts	49.1	38.9	42.1	42.6
Research consortiums	47.3	24.4	36.8	34.2
<i>Consulting</i> <i>N</i>	43.6 55	47.8 90	56.1 57	49.0 202
Expertises/reports for the business sector	29.1	32.2	36.8	32.7
Consulting for the business sector	36.4	42.2	50.9	43.1

(*): Paul-Scherrer Institute (PSI); EAWAG; EMPA; WSL.

Table 6: Main Forms of Knowledge and Technology Transfer Activities of Swiss Science Institutions by Science Institution
(percentage of institutes with values 4 or 5 for any of the single forms belonging to the same group of forms of KTT activities)

Institutions	Informal contacts, personal network of contacts	Technical facilities	Training, further education, staff mobility	Research	Consulting	N
Swiss Federal Institute of Zurich	72.5	10.0	75.0	77.50	40.0	40
Swiss Federal Institute of Technology Lausanne	71.4	28.6	85.7	85.71	57.1	7
Federal Research Institutions (*)	87.5	12.5	100.0	75.00	50.0	8
University of Basle	66.7	44.4	77.8	55.56	66.7	9
University of Berne	89.3	28.6	64.3	78.57	32.1	28
University of Fribourg	50.0	0.0	50.0	100.00	50.0	4
University of Geneva	60.0	20.0	80.0	70.00	60.0	10
University of Italian Switzerland	-	-	-	-	-	1
University of Lausanne	87.5	12.5	75.0	50.00	75.0	8
University of Neuchâtel	80.0	40.0	80.0	80.00	60.0	5
University of St. Gallen	71.4	0.0	100.0	71.43	85.7	7
University of Zurich	83.3	17.6	61.1	50.00	22.2	18
University of Applied Sciences of Berne	87.5	0.0	75.0	75.00	50.0	8
University of Applied Sciences of Central Switzerland	80.0	0.0	100.0	80.00	40.0	5
University of Applied Sciences of Eastern Switzerland	76.9	15.4	100.0	92.31	53.8	13
University of Applied Sciences of Italian Switzerland	50.0	0.0	100.0	50.00	50.0	2
University of Applied Sciences of North-western Switzerland	88.2	17.6	100.0	88.24	52.9	17
University of Applied Sciences of Western Switzerland	100.0	50.0	100.0	100.00	100.0	4
University of Applied Sciences of Zurich	75.0	12.5	87.5	87.50	62.5	8

(*): Paul-Scherrer Institute (PSI); EAWAG; EMPA; WSL.

Table 7: Main Forms of Knowledge and Technology Transfer Activities of Swiss Science Institutions by Scientific Field (percentage of institutes with values 4 or 5 for any of the single forms belonging to the same main group of forms of KTT activities)

Main forms of KTT activities	Informal contacts, personal network of contacts	Technical facilities	Training, further education, staff mobility	Research	Consulting	N
Engineering	83.8	17.6	93.2	81.1	54.1	74
Economics/Management	73.3	0.0	91.1	73.3	66.7	45
Medicine	83.0	23.4	57.4	63.8	40.4	47
Mathematics, Physics	60.0	30.0	70.0	80.0	10.0	10
Natural Sciences	73.1	32.0	69.2	80.8	34.6	26

Table 8: Funds from Outside Sources (percentage share of an institute's funds)

Institutions	N	Share of Funds from Outside Sources (means)		Share of Funds from the Business Sector (means)	
		unweighted	weighted	unweighted	weighted
Swiss Federal Institute of Zurich	44	39.2	36.4	36.5	34.7
Swiss Federal Institute of Technology Lausanne	10	39.7	43.5	13.5	16.1
Federal Research Institutions	11	43.2	25.4	32.5	60.7
University of Basle	10	37.9	32.2	53.8	30.7
University of Berne	26	40.6	28.6	42.2	45.5
University of Fribourg	4	42.8	38.2	31.3	20.9
University of Geneva	13	37.7	25.3	29.2	33.7
University of Italian Switzerland	2	100.0	100.0	40.0	42.0
University of Lausanne	11	28.5	13.9	36.2	24.5
University of Neuchâtel	6	41.0	44.0	18.2	16.8
University of St. Gallen	7	68.7	75.8	67.6	79.2
University of Zurich	19	32.4	28.0	22.4	21.8
University of Applied Sciences of Berne	9	31.2	19.3	59.3	74.1
University of Applied Sciences of Central Switzerland	5	53.2	61.4	49.0	48.2
University of Applied Sciences of Eastern Switzerland	14	59.4	29.4	60.8	76.0
University of Applied Sciences of Italian Switzerland	2	69.0	70.8	68.0	71.6
University of Applied Sciences of North-western Switzerland	15	43.6	12.6	45.6	77.0
University of Applied Sciences of Western Switzerland	4	25.5	25.9	47.3	45.3
University of Applied Sciences of Zurich	8	52.5	46.1	46.6	52.5

Weights: number of employees of single institutes.

Table 9: Output of Science Institutions in Co-operation with the Business Sector. Diplomas, Doctorates (percentage share of an institute's diplomas and doctorates respectively)

Institutions	N	Share of Diplomas (means)		Share of Doctorates (means)	
		unweighted	weighted	unweighted	weighted
Swiss Federal Institute of Zurich	41	20.7	14.0	19.9	20.2
Swiss Federal Institute of Technology Lausanne	10	14.0	18.6	10.5	14.1
Federal Research Institutions	10	6.7	10.1	11.1	17.8
University of Basle	8	9.4	5.9	12.3	7.7
University of Berne	19	14.3	25.1	12.7	14.3
University of Fribourg	4	8.5	4.8	12.5	17.1
University of Geneva	11	7.6	25.1	3.5	4.8
University of Italian Switzerland	1	-	-	-	-
University of Lausanne	4	0.0	0.0	10.9	8.8
University of Neuchâtel	4	7.8	6.3	12.8	9.0
University of St. Gallen	84	32.5	19.3	33.8	57.2
University of Zurich	11	6.4	7.7	15.0	6.6
University of Applied Sciences of Berne	9	57.8	56.0	//	//
University of Applied Sciences of Central Switzerland	5	68.0	65.1	//	//
University of Applied Sciences of Eastern Switzerland	13	80.5	84.4	//	//
University of Applied Sciences of Italian Switzerland	0	-	-	//	//
University of Applied Sciences of North-western Switzerland	17	67.7	82.1	//	//
University of Applied Sciences of Western Switzerland	3	79.0	81.7	//	//
University of Applied Sciences of Zurich	8	57.6	50.4	//	//

Weights: number of diplomas and doctorates respectively.

Table 10: Output of Science Institutions in Co-operation with the Business Sectors: Patents, Licences, Spin-offs

Institutions	N	% of Institutes with Patents	N	% of Patents in Co-operation with Firms (means)		N	% of Institutes with Licences	N	% of Institutes with Spin-offs
				unweighted	weighted				
Swiss Federal Institute of Zurich	45	51.1	21	45.2	57.9	45	13.3	45	33.3
Swiss Federal Institute of Technology Lausanne	12	41.7	5	44.4	55.1	12	33.3	12	41.7
Federal Research Institutions	11	36.4	4	36.0	36.9	11	45.5	11	36.4
University of Basle	11	45.5	5	64.0	66.7	11	9.1	11	9.1
University of Berne	33	21.2	6	67.2	67.4	33	3.0	33	15.2
University of Fribourg	5	20.0	1	100.0	100.0	5	20.0	5	0.0
University of Geneva	15	33.3	5	62.0	46.3	14	21.4	15	13.3
University of Italian Switzerland	2	0.0	0	-	-	0	-	2	50.0
University of Lausanne	12	33.3	3	90.0	72.7	12	8.3	12	8.3
University of Neuchâtel	6	50.0	3	63.3	55.6	6	16.7	6	16.7
University of St. Gallen	8	0.0	0	-	-	8	12.5	7	28.6
University of Zurich	22	31.8	7	64.6	58.4	22	4.5	22	4.5
University of Applied Sciences of Berne	9	33.3	2	100.0	100.0	9	0.0	9	55.6
University of Applied Sciences of Central Switzerland	5	0.0	0	-	-	5	20.0	5	20.0
University of Applied Sciences of Eastern Switzerland	14	35.7	5	100.0	100.0	14	7.1	14	14.3
University of Applied Sciences of Italian Switzerland	2	0.0	0	-	-	2	0.0	2	0.0
University of Applied Sciences of North-western Switzerland	17	35.3	5	100.0	100.0	17	5.9	17	17.6
University of Applied Sciences of Western Switzerland	4	50.0	2	50.0	18.2	4	0.0	4	50.0
University of Applied Sciences of Zurich	8	37.5	3	67.7	51.5	8	12.5	8	12.5
All institutes	241	34.4	77			238	12.2	239	21.7

Weights: number of patents.

Table 11: Transfer-mediating Institutions (percentage share of institutes reporting values 4 or 5)

Institutions	N	Transfer Office	KTI	SNF	EU Framework	Other EU programmes
Swiss Federal Institute of Zurich	40	22.5	35.0	15.0	35.0	7.5
Swiss Federal Institute of Technology Lausanne	7	28.6	85.7	28.6	57.1	42.9
Federal Research Institutions	8	25.0	37.5	0.0	37.5	25.0
University of Basle	9	0.0	0.0	11.1	0.0	0.0
University of Berne	28	10.7	28.6	28.6	7.1	7.1
University of Fribourg	4	0.0	0.0	25.0	25.0	25.0
University of Geneva	9	11.1	0.0	44.4	22.2	22.2
University of Italian Switzerland	1	-	-	-	-	-
University of Lausanne	8	37.5	25.0	50.0	12.5	25.0
University of Neuchâtel	5	20.0	20.0	60.0	60.0	60.0
University of St. Gallen	7	14.3	28.6	14.3	14.3	28.6
University of Zurich	16	37.5	18.8	31.3	18.8	6.3
University of Applied Sciences of Berne	8	0.0	25.0	0.0	0.0	0.0
University of Applied Sciences of Central Switzerland	5	20.0	20.0	0.0	0.0	0.0
University of Applied Sciences of Eastern Switzerland	13	23.1	38.5	7.7	15.4	15.4
University of Applied Sciences of Italian Switzerland	2	0.0	0.0	0.0	0.0	0.0
University of Applied Sciences of North-western Switzerland	17	5.9	29.4	5.9	11.8	5.9
University of Applied Sciences of Western Switzerland	4	25.0	50.0	0.0	50.0	25.0
University of Applied Sciences of Zurich	8	12.5	50.0	12.5	12.5	12.5
All institutes	199	16.8	27.7	19.6	20.6	12.9

Table 12: Transfer Media (percentage share of institutes reporting values 4 or 5)

Institutions	N	Academic Publications	Patents	Licences	Spin-offs/ start-ups
Swiss Federal Institute of Zurich	40	52.5	35.0	17.5	35.0
Swiss Federal Institute of Technology Lausanne	7	42.9	28.6	42.9	71.4
Federal Research Institutions	8	75.0	37.5	25.0	0.0
University of Basle	9	66.7	11.1	11.1	11.1
University of Berne	28	64.3	25.0	17.9	17.9
University of Fribourg	4	50.0	0.0	0.0	0.0
University of Geneva	9	77.8	22.2	22.2	0.0
University of Italian Switzerland	1	-	-	-	-
University of Lausanne	8	75.0	25.0	25.0	12.5
University of Neuchâtel	5	80.0	20.0	20.0	40.0
University of St. Gallen	7	71.4	0.0	14.3	14.3
University of Zurich	18	66.7	22.2	22.2	5.6
University of Applied Sciences of Berne	8	25.0	0.0	0.0	0.0
University of Applied Sciences of Central Switzerland	5	40.0	0.0	0.0	0.0
University of Applied Sciences of Eastern Switzerland	12	41.7	8.3	8.3	16.7
University of Applied Sciences of Italian Switzerland	2	50.0	0.0	0.0	0.0
University of Applied Sciences of North-western Switzerland	17	64.7	5.9	5.9	11.8
University of Applied Sciences of Western Switzerland	4	75.0	25.0	50.0	50.0
University of Applied Sciences of Zurich	8	75.0	37.5	12.5	0.0
All institutes	200	60.0	21.0	16.7	17.6

Table 13: Motives, Objectives for KTT Activities of Science Institutions by Type of Science Institution (percentage share of institutes with values 4 or 5 for a single motive or any of the single motives belonging to the same category of motives)

Motives	ETH Domain	Universities	Universities of Applied Sciences	Total
<i>Financial Motives</i>	90.9	84.4	98.2	90.1
<i>N</i>	55	90	57	202
Cost savings	20.0	32.2	28.1	27.7
Time savings	12.7	20.0	21.1	18.3
Additional resources for basic research	49.1	58.9	15.8	44.1
Additional resources for research facilities	50.9	47.8	22.8	41.6
Commercial success	32.7	15.6	47.4	29.2
Business funding more flexible than public funding	47.3	48.9	26.3	42.1
Reference for more public funding	50.9	24.4	66.7	43.6
Applied research possible only in collaboration	72.7	60.0	87.7	71.3
<i>Access to human capital (tacit knowledge)</i>	81.5	64.8	86.0	75.4
<i>N</i>	54	88	57	199
Access to specific capabilities complementary to own ones	46.3	40.9	54.4	46.2
Research impetus	55.6	42.0	63.2	51.8
Exchange of experience with industrial researchers	51.9	35.2	54.4	45.2
Practical experience for staff/students	55.6	37.5	59.6	48.7
Additional insights in own research field	48.1	37.5	63.2	47.7
<i>Access to business sector research findings (codified knowledge)</i>	42.6	32.6	64.9	44.5
<i>N</i>	54	89	57	200
Access to patents, licenses	3.7	6.7	10.5	7.0
Gaining knowledge about practical problems for curriculum	40.7	29.2	63.2	42.0

<i>Access to business sector R&D facilities</i>	50.0	39.8	46.4	44.4
<i>N</i>	54	88	56	198
Access to technological equipment, specialised technology	7.4	23.9	12.5	16.2
Test own research findings in practice	50.0	29.5	42.9	38.9
<i>Institutional or organisational motives</i>	81.5	62.9	87.7	75.0
<i>N</i>	54	89	57	200
Securing good job prospects for students/staff	51.9	37.1	57.9	47
Presence of business representatives in university's academic consultant bodies	18.5	22.5	49.1	29.0
Extending university's mission	44.4	32.6	56.1	42.5
Promoting the diffusion of a particular technology	57.4	30.3	56.1	45.0
Promoting the diffusion of key findings	44.4	32.6	63.2	44.5
Promoting regional development	25.9	30.3	63.2	38.5
Improving image of science	38.9	43.8	36.8	40.5

Table 14: Main Categories of Motives for KTT Activities by Science Institution (percentage share of institutes with values 4 or 5 for any of the single motives belonging to the same group of motives)

Institutions	N	Financial Motives	Access to human capital (tacit knowledge)	Access to firms' research findings (codified knowledge)	Access to business sector R&D facilities	Institutional or organisational motives
Swiss Federal Institute of Zurich	40	87.5	79.5	35.9	48.7	76.9
Swiss Federal Institute of Technology Lausanne	7	100.0	85.7	71.4	71.4	100.0
Federal Research Institutions	8	100.0	87.5	50.0	37.5	87.5
University of Basle	9	77.8	55.6	11.1	33.3	55.6
University of Berne	28	89.3	66.7	25.0	40.7	50.0
University of Fribourg	4	75.0	100.0	50.0	25.0	75.0
University of Geneva	10	90.0	55.6	33.3	44.4	100.0
University of Italian Switzerland	1	-	-	-	-	-
University of Lausanne	8	75.0	50.0	25.0	25.0	62.5
University of Neuchâtel	5	80.0	80.0	40.0	80.0	80.0
University of St. Gallen	7	85.7	71.4	71.4	42.9	71.4
University of Zurich	18	83.3	61.1	38.9	33.3	55.6
University of Applied Sciences of Berne	8	100.0	62.5	37.5	25.0	75.0
University of Applied Sciences of Central Switzerland	5	100.0	100.0	80.0	0.0	60.0
University of Applied Sciences of Eastern Switzerland	13	100.0	100.0	76.9	46.2	100.0
University of Applied Sciences of Italian Switzerland	2	100.0	100.0	0.0	50.0	50.0
University of Applied Sciences of North-western Switzerland	17	94.1	76.5	58.8	47.1	94.1
University of Applied Sciences of Western Switzerland	4	100.0	100.0	100.0	100.0	100.0
University of Applied Sciences of Zurich	8	100.0	87.5	75.0	71.4	87.5

Table 15: Main Categories of Motives by Scientific Field (percentage share of institutes with values 4 or 5 for any of the single motives belonging to the respective group of motives)

	N	Financial motives	Access to human capital ("tacit knowledge")	Access to business research findings ("codified knowledge")	Access to business sector R&D facilities	Institutional or organizational motives
Scientific fields						
Engineering	74	93.2	83.8	55.4	51.4	87.8
Economics/Management	45	93.3	77.8	66.7	45.5	84.4
Medicine	47	85.1	58.7	21.3	34.8	48.9
Mathematics, Physics	10	100.0	77.8	11.1	11.1	66.7
Natural Sciences	26	80.8	76.0	28.0	52.0	72.0

Table 16: Obstacles of KTT Activities of Science Institutions by Type of Science Institution
 (percentage share of institutes with values 4 or 5 for a single obstacle or any of the single obstacles belonging to the same group of obstacles)

Obstacles	ETH Domain	Universities	Universities of Applied Sciences	Total
<i>Lack of information</i>	46.2	44.4	50	46.5
<i>N</i>	52	90	56	198
Lack of Information about firms' research activities	36.5	27.8	28.6	30.3
Difficulty to find an appropriate partner	28.8	32.2	28.6	30.3
Interface to the business sector poorly equipped	11.5	11.1	23.2	14.6
<i>Problems in the areas of teaching, basic research</i>	42.3	57.8	57.7	53.6
<i>N</i>	52	90	52	194
Teaching requires too much time	11.5	40.0	42.3	33.0
Scientific independence impaired	11.5	21.1	13.5	16.5
Hindrance to academic publication activities	25.0	18.9	5.8	17.0
Neglecting basic research	13.5	20.0	11.5	16.0
<i>Necessary conditions for KTT lacking among potential partners in the business sector</i>	57.7	41.6	46.4	47.2
<i>N</i>	52	89	56	197
Lack of qualified staff	21.2	7.9	12.5	12.7
Lack of technical facilities	5.8	2.2	0.0	2.5
Lack of interest in scientific projects	50.0	37.1	41.1	41.6
Insufficient interesting research questions	21.2	20.2	23.2	21.3
<i>Necessary conditions for KTT lacking in institute</i>	29.6	45.5	42.9	40.4
<i>N</i>	54	88	56	198
Lack of academic specialists for KTT activities	18.5	33.0	32.1	28.8
Approach of staff not entrepreneurial enough	11.1	18.2	23.2	17.7
Insufficient interesting research focus for firms	3.7	14.8	7.1	9.6
No possibility of commercialising research findings	11.1	17.0	10.7	13.6

<i>Costs, risks, uncertainty</i>	63.5	31.5	62.5	48.7
<i>N</i>	<i>52</i>	<i>89</i>	<i>56</i>	<i>197</i>
Uncertainty about R&D results	21.2	10.1	14.3	14.2
Differing ideas on costs and/or productivity	28.8	16.9	25.0	22.3
R&D budgets of potential business partners too low	53.8	23.6	60.7	42.1
<i>Organisational, institutional obstacles</i>	61.5	57.3	64.3	60.4
<i>N</i>	<i>52</i>	<i>89</i>	<i>56</i>	<i>197</i>
Resource-intensive administrative and approval procedures, legal restrictions	26.9	39.3	46.4	38.1
Lack of project administration support on the part of the academic institution	9.6	24.7	28.6	21.8
Lack of support for the commercialisation of findings on the part of the academic institution	19.2	15.7	16.1	16.8
Property Rights problems	26.9	13.5	5.4	14.7
Project management problems	11.5	12.4	16.1	13.2
Different views on urgency with regard to scheduling	28.8	18.0	28.6	23.9
Lack of confidence	3.8	3.4	7.1	4.6
Reputation at risk	5.8	3.4	8.9	5.6

Table 17: Main Categories of Obstacles of KTT Activities of Science Institutions by Science Institution (percentage share of institutes with values 4 for any of the single obstacles belonging to the same group of obstacles)

Institutions	N	Lack of information	Problems in the areas of teaching, basic research	Necessary conditions for KTT lacking in business sector	Necessary conditions for KTT lacking in institute	Costs, risks, uncertainty	Organisational, institutional obstacles
Swiss Federal Institute of Zurich	37	43.2	37.8	48.6	20.5	62.2	59.5
Swiss Federal Institute of Technology Lausanne	7	57.1	85.7	85.7	71.4	71.4	71.4
Federal Research Institutions	8	50.0	25.0	75.0	37.5	62.5	62.5
University of Basle	9	66.7	77.8	55.6	66.7	44.4	66.7
University of Berne	28	42.9	53.6	28.6	33.3	33.3	60.7
University of Fribourg	4	25.0	25.0	50.0	50.0	0.0	0.0
University of Geneva	10	50.0	80.0	50.0	88.9	10.0	70.0
University of Italian Switzerland	1	-	-	-	-	-	-
University of Lausanne	8	25.0	25.0	14.3	25.0	12.5	62.5
University of Neuchâtel	5	60.0	80.0	40.0	60.0	20.0	80.0
University of St. Gallen	7	28.6	71.4	57.1	0.0	28.6	16.7
University of Zurich	18	50.0	55.6	50.0	55.6	55.6	55.6
University of Applied Sciences of Berne	8	25.0	75.0	37.5	50.0	50.0	50.0
University of Applied Sciences of Central Switzerland	5	100.0	40.0	100.0	100.0	80.0	100.0
University of Applied Sciences of Eastern Switzerland	13	61.5	50.0	38.5	30.8	76.9	76.9
University of Applied Sciences of Italian Switzerland	2	50.0	100.0	50.0	0.0	100.0	0.0
University of Applied Sciences of Northwestern Switzerland	16	31.3	50.0	43.8	41.2	50.0	62.5
University of Applied Sciences of Western Switzerland	4	25.0	100.0	50.0	50.0	75.0	50.0
University of Applied Sciences of Zurich	8	75.0	57.1	37.5	28.6	50.0	62.5

Table 18: Main Categories of Obstacles of KTT Activities of Science Institutions by Scientific Field (percentage share of institutes with values 4 for any of the single obstacles belonging to the same group of obstacles)

Scientific field	N	Lack of information	Teaching Problems, basic research	Necessary conditions for KTT lacking in business sector	Necessary conditions for KTT lacking in institute	Costs, risks, uncertainty	Organisational, institutional obstacles
Engineering	72	48.6	52.9	49.3	31.1	62.0	63.4
Economics/Management	45	44.4	62.2	53.3	43.2	44.4	54.5
Medicine	47	48.9	48.9	39.1	45.7	37.0	68.1
Mathematics, Physics	10	40.0	40.0	60.0	33.3	40.0	60.0
Natural Sciences	24	41.7	54.2	40.0	56.0	44.0	48.0

Table 19: Impact of KTT Activities by Type of Science Institution (percentage share of institutes)

Impact	ETH Domain	Universities	Universities of Applied Sciences
<i>Change of financial position</i>			
<i>N</i>	54	87	57
No change	14.8	17.2	19.3
Additional resources for research	83.3	77.0	73.7
Additional resources for teaching	13.0	12.6	7.0
Additional resources for technical facilities	37.0	43.7	28.1
<i>Change of research orientation</i>			
<i>N</i>	53	88	57
No change	62.3	54.5	26.3
More geared to applied research	39.6	46.6	73.7
More geared to basic research	5.7	2.3	0.0
<i>Teaching, further education or further training activities</i>			
<i>N</i>	54	87	56
No impact	33.3	54.0	10.7
Education provided is more geared towards practice	63.0	42.5	83.9
Less time available for teaching and student support	7.4	8.0	23.2
<i>Scientific reputation</i>			
<i>N</i>	53	86	57
No change	35.8	44.2	12.3
Better reputation	66.0	54.7	86.0
Worse reputation	0.0	1.2	1.8