Knowledge and Technology Transfer between Universities and Private Enterprises in Switzerland 2011

An Analysis Beased on Firm and Institute Data

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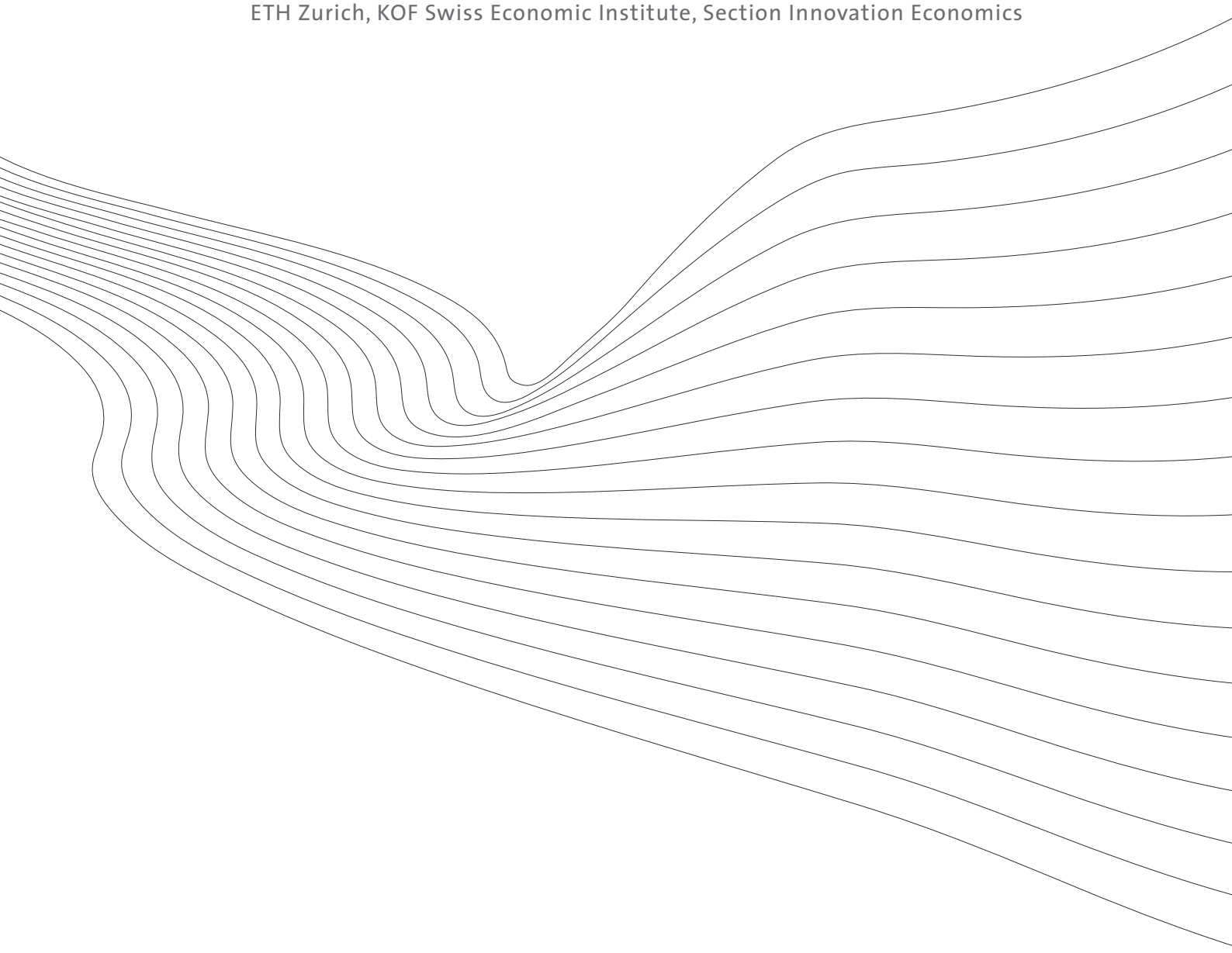

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1. Introductory remarks

This study refers to the results of a KOF project that was undertaken on behalf of the ETH Board and aimed at the investigation of a) the extent and b) the economic relevance of *knowledge and technology transfer* (KTT) between science institutions (institutions of the ETH Domain[1], Cantonal Universities and Universities of Applied Sciences) and private corporations in Switzerland.

The term *knowledge and technology transfer* broadly denotes any activities targeted at transferring knowledge and technology that may help a company or a research institution – depending on the direction of the transfer – to further promote its activities. However, institutions of the ETH-Domain collaborate within the KTT-framework not only with companies but also with public institutions such as federal, cantonal and local authorities and agencies. They support public institutions in using the latest findings of research and development in order to fulfil their tasks. This dimension of KTT is not part of the study presented here.

Both conceptually and statistically this study builds on the previous study referring to the results of the firm and institute survey 2005 (based on the same questionnaires), which was also mandated by the ETH Board (see Arvanitis et al. 2006).[2] The data for this study were collected, first, by means of a large postal survey of Swiss enterprises from all sectors of the economy and, second, by a further postal survey that was conducted among institutes and/or departments of all three types of science institutions in Switzerland (institutions of the ETH Domain, Cantonal Universities and regional Universities of Applied Sciences) covering all scientific fields related to technology and science.

In chapter 2 the questionnaire and the statistical base are presented. Chapter 3 contains a detailed descriptive analysis of KTT activities of a series of relevant variables (incidence of KTT by industry and firm size class; science partners and mediating institutions of KTT; motives for and obstacles of KTT activities; impact of KTT activities) from the *point of view of private enterprises.* In the chapters 4 to 6 the results of a more explorative analysis based on econometric methods are presented. The analysis in chapter 4 refers to the drivers of the propensity to KTT activities. Chapter 5 deals with the impact of KTT activities on innovation and economic performance. Chapter 6 refers to the comparison of the determinants of knowledge *exploitation* and knowledge *exploration* activities with respect to KTT, an

[1] Institutions of the ETH Domain: ETH Zurich, EPFL, Paul Scherrer Institute (PSI), Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Swiss Federal Laboratories for Materials Science and Technology (EMPA) and Swiss Federal Institute of Aquatic Science and Technology (EAWAG). These abbreviations are used in the following text.

[2] The data of the firm survey 2005 and the institute survey 2005 served as base for the following scientific publications: Arvanitis et al. (2011) refers to the determinants of KTT activities from the *business* point of view;, Arvanitis et al.(2008b; 2008c) refer to the impact of KTT activities on firm inovatin and economic performance; Arvanitis and Wörter (2009) refers to KTT stategies; and Arvanitis et al. (2008a) deals with the determinants of KTT actvities from the *science* point of view.

investigation that is conducted for the first time for Swiss firms. Chapter 7 presents the results of the survey of the science institutions. Chapter 8 contains a summary and conclusions.

2. Data Collection and Statistical Base

2.1 Questionnaire

The data were collected by means of a survey carried out in Spring 2011. We used basically the same questionnaire as in the previous survey 2005.[3] We added a new question referring to the technological fields, in which firms are active. Further, we extended the question referring to the partners of KTT activities, so that in the questionnaire 2011 firms reported not only the science institutions with which they cooperated, but also the forms of KTT activities they were engaged in. We also used a second questionnaire for science institutions that was identical with that in the previous survey 2005. This second questionnaire is symmetrical to the one addressed to firms, so that we can compare the two points of view (firms and scientific institutes). The combined information allows for identifying the dis(incentive) structures for KTT and localise areas of problems that could be treated by technology policy. The questionnaires comprise the following topics (see Table 2.1 and the questionnaires themselves in the appendix):

Table 2.1: Main categories of the questionnaires in comparison

Questionnaire for firms:	Questionnaire for scientific institutes:
-Firm characteristics and performance indicators	-Characteristics of the institute and financial resources
-Innovation and R&D activities	-Performance in teaching and research
-Forms and media of KTT with scientific institutions	-Forms of KTT between institutes and the business sector, and channels used
-Scientific partners for KTT	-Motivation and objectives for KTT with the business sector
-Motivation and objectives for KTT with scientific institutions	-Impact of KTT with the business sector
-Impact of KTT with scientific institutions	-Obstacles to KTT with the business sector
-Obstacles to KTT with scientific institutions	

2.2 Composition of the sample and response rates

The data for this study were collected, first, by means of a large postal survey of Swiss enterprises from all sectors of the economy (with the exception of hotels/catering, retail trade, real estate/leasing and personal services) and from different size classes. This was based on a questionnaire on the exchange of knowledge and technology with Swiss universities and other

[3] Based on the results of a comprehensive pilot study (see Arvanitis and Wörter 2004) the questionnaire was designed to take into account also the information from available surveys from other countries.

research institutions. Answers were received from 1,841, i.e. 40% of the firms in the underlying sample. Of these firms, 469 reported KTT activities for the period 2008-2010. Table A1 in the Appendix shows the composition of the final dataset according to industry (in comparison with the 2002-2004 survey). The data presented in the tables referring to firms are weighted so as to represent the actual underlying structure of the private sector in Switzerland (for firms with more than 5 employees in full-time equivalents) unless otherwise stated.

A second survey was conducted among institutes and/or departments of all three types of research institutions in Switzerland (institutions of the ETH Domain, Cantonal Universities and regional Universities of Applied Sciences) covering all scientific fields related to technology and science. Answers were received from 164 institutes, i.e. about 28% of all institutes addressed. Of these institutes, 145 reported KTT activities in the period between 2008 and 2010. Table A.2 in the Appendix shows the composition of the final dataset according to the group of science institutions (in comparison with the 2002-2004 survey). The data presented in the tables referring to science institutions are not weighted.

2.3 Statistical basis

Sampling plan and response rates

The firm survey was based on the KOF firm-panel. This is a (with respect to firm size) disproportional stratified random sample, drawn from the national census of enterprises (2001) and containing firms with more than five employees. The sample covers 29 2-digit industries (NOGA classification) form all sectors of the economy and - within each of industry - three different size classes with a complete coverage of large firms. The limits for the three size classes (criterion: employment in full-time equivalents) are determined by "optimal stratification" that takes into account the different size distributions of firms within industries.

The firm survey was addressed to all industries in the sample with the exception of retail trade, hotels and restaurants, real estate and personal services. We excluded firms in these industries, since it is quite unlikely that they have KTT activities with universities. The questionnaire was sent to 4604. The response rates are similar in the different sectors. Focusing on the single industries, we find the highest response rate in the plastics industry (52.1%) and the lowest in the clothing/leather business (21.1%). On the whole, response rates of single industries do not differ much from each other (see Table A.3 in the Appendix).

The overall response rate and the distribution of the responses between the different industries and sectors is quite satisfactory, especially if we compare with similar surveys in other countries and if we take into account that the subject of the survey is rather specific and does not interest all firms equally. The very intensive recall action contributed heavily to yielding an overall satisfactory response rate.

Missing values

Firms sometimes leave some questions unanswered, which may distort our results. This problem was addressed with the statistical method of "multiple imputation" (see Rubin 1987).

Weighting schemes

An adequate weighting procedure of the answers taking into consideration all available information on selection bias, on possible structural deviations from the sample (stratification) as well as from the population is a comprehensive work which is related to important theoretical as well as empirical questions (see e.g. Kish 1992). In the following paragraph we briefly present the weighting scheme used in our calculations. Step by step we take into account the statistical sampling plan (stratification) and the non-response rate in total.

Sampling plan

For each observation (firm) i of layer h (h=1,…,84) we define a weight w_{hi}:

$$w_{hi} = 1/f_h = 1/(n_h/N_h) = N_h/n_h$$

f_h: sampling rate of layer h;
n_h: number of firms in layer h in the sample;
N_h: number of firms in layer h in the population 2001

Non-response rate:

For each firm i in the layer h we define a weight $1/r_{hi}$, where r_{hi} represents the probability that the firm i gives an answer. Actually this probability is not known, therefore we have to estimate it based on a logistic regression of the non-response rate[4] on the structural characteristics such as industry affiliation, size class or region. By taking into account r_{hi} we obtain the following weight:

$$w_{hi}^{*} = w_{hi}\ 1/r_{hi}$$

This weight is used throughout in the calculation of the tables of the results of the firm survey.

Definition of sub-sector and firm size classes

In the subsequent chapters we distinguish four subsectors that are defined as follows:

High-tech manufacturing: chemicals, plastics, machinery, electrical machinery, vehicles, electronics/instruments:

Low-tech manufacturing: food/beverage, textiles, clothing/leather, wood processing, paper, printing, glass/stone, clay, metal metalworking, watches, other manufacturing, energy/water;

[4] Dependent variable: dummy variable (value 1 for responding firms and value 0 for not responding firms).

Modern services: banking/insurance, computer services, business services, telecommunication;

Traditional services: wholesale trade, transport.

We also define three firm size classes:

Small-sized: 5 to 49 employees in full-time equivalents;

Medium-sized: 50 to 249 employees in full-time equivalents;

Large firms: 250 employees in full-time equivalents and more.

3. KTT activities in the Swiss economy: The main facts from the *firm* point of view

3.1 Incidence of KTT activities

According to the survey results, about 21% of all firms in the sample were involved in KTT activities with universities and other research institutions between 2008 and 2010 (Table 3.1). In the period of 2002-2004 the respective figure was 22%. *Thus, the share of firms with KTT activities has remained approximately constant in the past six years*. The share of firms with KTT activities is almost the same in the manufacturing and in the service sectors (28% and 25% respectively). Only 4% of firms in the construction sector are involved in KTT activities. Firms in high-tech manufacturing (i.e. the most innovative part of manufacturing industries) and in knowledge-based services (banking, insurance, and business services such as engineering and computer software) show the highest incidence of KTT activities. Especially firms in the chemical industry (including pharmaceuticals), in vehicles, in electronics/ instruments and in business services are most often involved in KTT. *There is a significant increase in the share of KTT-active firms in high-tech manufacturing and in knowledge-based services*, but also a discernible decrease in the respective share in low-tech manufacturing as well as in ”traditional” services (see Arvanitis et al. 2005 for a detailed description of the results of the 2005 survey).

Table 3.1: Incidence of KTT activities; percentage share of firms according to sector, sub-sector and firm size class

	2002-2004	Abroad 2002-2004	2008-2010	Abroad 2008-2010
Sectors				
Manufacturing	25.1	13.2	28.0	8.7
Construction	10.1	4.1	4.3	1.1
Services	26.7	8.3	24.6	4.7
Subsectors				
High-tech	28.3	18.9	44.6	15.9
Low-tech	23.4	10.1	16.7	3.8
Modern services	27.2	9.2	35.2	6.1
Traditional services	26.2	7.4	10.6	2.9
Size				
Small (5-49 empl.)	19.4	7.7	16.2	2.5
Medium (50-249 empl.)	33.7	11.9	34.7	11.6
Large (> 250 empl.)	44.9	18.3	57.3	27.8
Total	*22.2*	*8.6*	*21.1*	*5.0*

There is a considerable size-dependency with respect to KTT activities. The percentage of small firms with KTT activities is 16%, that of medium-sized firms is considerably higher,

namely 35%, and the respective percentage for large firms is 57%. *This means that every second large firm in Switzerland (i.e. with 250 and more employees) is involved in KTT activities*.

Table 3.2: Incidence of KTT activities; percentage share of firms according to region

Swiss regions	2002-2004	2008-2010
Lake Geneva	12.9	13.0
Swiss Midlands	22.4	18.5
Northwestern Switzerland	21.7	23.7
Zurich	35.0	25.6
Eastern Switzerland	19.9	23.9
Central Switzerland	21.4	28.9
Ticino	7.4	7.4
Total	*22.2*	*21.1*

The incidence of KTT activities according to region in Table 3.2 shows that since 2002-2004, the share of firms from Zurich has significantly decreased, while that of central Switzerland has increased. The share of all other regions has remained almost constant.

3.2 Forms of KTT activities

The KTT-active firms were asked to assess the importance of 19 different single forms of KTT activities on a five-point Likert scale ranging from 1 ("not important") to 5 ("very important"). These 19 single forms were classified in five categories: *informal contacts* with a primarily general informational character, *educational activities*, (including joint master thesis and doctoral projects), activities related to the use of *technical infrastructure* (including firm assignments, for example, for specific measurements that could be conducted only with the specialized equipment of research institutions), *research activities* and *consulting*.

Table 3.3: Main categories of forms of KTT activities; percentage of firms with KTT activities(*)

	Information	Infrastructure	Education	Research	Consulting
Total 2011	*62.9*	*13.9*	*59.3*	*17.1*	*14.8*
Total 2005	*56.6*	*11.9*	*52.3*	*17.8*	*15.3*

(*): Percentage of firms reporting 4 or 5 on a five-point Likert scale (1: "not important"; 5: very important") for any of the single forms of KTT activities in a certain main category of forms of KTT activities.

Table 3.4: Main categories of and single forms of KTT; percentage of firms with KTT activities

KTT main forms(*) */ single forms*(**)	
INFORMATION	*62.9*
Informal contacts	29.3
Attending conferences	37.0
Reading of, reference to publications	34.6
INFRASTRUCTURE	*13.9*
Joint laboratories	5.2
Use of university technical infrastructure	12.7
EDUCATION	*59.3*
Employing graduates in R&D	25.3
Contact of graduates with university	12.1
Students' participation in firm R&D	16.0
Diploma thesis	24.4
PhD	6.0
University researchers' participation in firm R&D	6.3
Joint courses	7.6
Teaching of firm researchers at university	17.0
Attending university training courses	41.0
RESEARCH	*17.1*
Joint R&D projects	15.8
Long-term research contracts	4.5
Research consortium	4.3
CONSULTING	*14.8*
Expertise	9.3
Consulting	13.0

(*): Firms reporting 4 or 5 on a five-point Likert scale (1: “not important”; 5: very important”) for any of the *single* forms of KTT activities in a certain main category of forms of KTT activities;
(**): Firms reporting 4 or 5 on a five-point Likert scale (1: “not important”; 5: “very important”) for a *single* form of KTT activity.

About 60% of KTT-active firms in Switzerland found (a) informal, personal contacts that aim at gaining some general information on technological opportunities and/or (b) a wide

spectrum of educational activities as the most important forms of KTT activities (Table 3.3). 17% had a focus on research activities, 15% on consulting, 14% on the utilisation of university infrastructure facilities. *There is a slight increase in informational and educational activities as compared to the period of 2002-2004. The proportion of firms engaged in research and consulting activities has remained approximately constant in the past six years.*

Table 3.4 presents the percentage of firms reporting high importance of a single form of KTT activities. In the main group "information", firms' preferences are almost equally distributed among "informal contacts", "attending conferences" and "publications". The most frequently reported educational activities leading to KTT are "attending university training courses" (41%), "employing graduates in R&D" (25%) and "joint degree (mostly Master's) thesis" (24%). Only 6% of KTT-active firms find joint PhDs important.[5]

3.4 Partners of KTT activities

Firms also reported the institution(s) (institutions of the ETH Domain, Cantonal Universities and Universities of Applied Sciences) with which they interacted. Many firms reported more than one institution. 70% of all KTT-active firms reported an interaction with institutions of the ETH Domain, 56% with Universities of Applied Sciences, significantly less with Cantonal Universities (43%). There are significant differences as to the former period (Table 3.5). *The percentage of all three types of science institutions has increased since 2002-2004, but the increase for the ETH Domain and for the Universities of Applied Sciences was discernibly larger than that of the Cantonal Universities.*

Table 3.5: Percentage of firms with KTT activities with a certain science institutions as KTT partner

Science Institutions	2002-2004	2008-2010
ETH Domain	*57.0*	*70.0*
ETH Zurich	31.5	58.4
EPFL	19.1	19.1
PSI	7.9	10.8
EAWAG	3.2	13.6
EMPA	25.4	30.9
WSL	7.5	8.2
Cantonal Universities	*38.0*	*42.8*
Universities of Applied Sciences	*56.0*	*68.6*

[5] One may argue that joint PhD theses (possibly also Master's theses) are also part of research, and thus the percentage of research-oriented activities would be effectively higher than 17% as reported in Table 3.4. The percentage of firms reporting joint PhDs that *also* report joint R&D projects amounts to 62.8% (the respective percentages for long-term research contracts and research consortia are 44.2% and 37.2%, respectively). For firms reporting PhDs but *not* research contracts *as well*, it is reasonable to assume that the educational component of PhDs is the dominant motive for such joint activities. As a consequence, there appears to be no need for a discernible correction of the research figure in Table 3.4.

Table 3.6 shows the percentage of firms with KTT activities with institutions of a certain type of science institution as KTT partners by sector, subsector and firm size class. The business partners of the institutions of the ETH Domain and the Universities of Applied Sciences are evenly distributed among the three sectors of manufacturing, construction and services. The Cantonal Universities have a considerably higher proportion of partners in the service sector than in manufacturing and construction. The institutions of the ETH Domain cooperate to a greater extent with high-tech firms and firms from the more knowledge-intensive service industries than the other two groups of science institutions. Large firms seem to engage more frequently in KTT activities than smaller ones independent of the type of science institutions.

Table 3.6: Percentage of firms that have KTT activities a certain type of science institution as KTT partners; according to sector, subsector and firm size class

	ETH Domain	Cantonal Universities	Universities of Applied Sciences
Sectors			
Manufacturing	71.2	36.8	70.4
Construction	74.2	34.1	60.6
Services	69.0	47.2	68.1
Subsectors			
High-tech	76.9	36.2	75.1
Low-tech	60.8	38.0	61.8
Modern services	74.8	49.9	68.1
Traditional services	43.0	35.6	68.1
Size			
Small (5-49 empl.)	65.1	37.4	67.0
Medium (50-249 empl.)	76.5	49.3	69.6
Large (> 250 empl.)	79.9	55.4	76.2
Total	*70.0*	*42.8*	*68.6*

Table 3.7 shows the percentage of firms that pursue KTT activities with partners from a certain group of science institutions according to the main forms of KTT activities. The sum of the percentages along a *row* in Table 3.7 adds up to 100%. Thus these percentages reflect the "*KTT portfolio"* or the "*degree of KTT specialisation"* of the institutions or groups of institutions. Many firms reported not only more than one institution but also more than one group of KTT activities. As a consequence, the sum of the "contacts" as reported in Table 3.7 is in general larger than the number of firms contacting a certain institution or group of institutions.

It is worth noting that the research institutions of the ETH Domain, with the exception of EMPA, have a greater frequency of informational contacts with firms compared to ETH

Zurich or EPFL. In contrast, it can be observed that EPFL and EMPA have considerably more transfer activities dedicated to collaborative research projects. The share of research contacts of EPFL (13.2%) is considerably higher than that of ETH Zurich (6.9%). Further, it can be seen EMPA shows not only the highest share of research contacts but also the highest share of educational contacts.

In the case of the Cantonal Universities there are relatively many informational contacts with the University of Lausanne and frequent infrastructure-related contacts with the University of St. Gallen. Education-related transfer activities are also frequently found at the University of St. Gallen, while research collaborations have a relatively great frequency at the University of Fribourg, and the Università della Svizzera italiana stands out through its consulting activities.

The Universities of Applied Sciences (UAS) show a rather homogeneous picture as far as the informational transfer contacts are concerned. The reported frequency lies between 38% and 45%. More differences can also be observed in terms of infrastructure and education. The firms reported relatively frequent contacts with Central Switzerland and Berne concerning infrastructure-related contacts, and Eastern Switzerland has frequent education-related contacts. Research collaborations are of similar frequency at the UAS of Southern Switzerland, Western Switzerland, and Central Switzerland. Consulting, like informational contacts, is quite equally distributed.

Table 3.8 shows the percentage of contacts of a science institution in relation to the total number of contacts of all institutions for every main form of KTT activity. In this case, the sum-total of contacts along a *column* in Table 3.8 adds up to 100%. The proportion of an institution for a certain form of KTT activity reflects the *relative importance* of this institution for this category of KTT activity.

In the ETH Domain the three largest institutions, ETH Zurich, EPFL and EMPA, also show the largest shares in all five categories of KTT activities. It is worth pointing out that ETH Zurich and EPFL have equal shares of research-related contacts, though ETH Zurich has almost the twice the number of personnel and resources.

When it comes to the Cantonal universities, it can be seen that the University of St.Gallen has an above-average proportion of contacts with respect to informational, educational, infrastructure-related and consulting activities. The University of Zurich has an above-average proportion of research-oriented contacts.

Among the Universities of Applied Sciences (UAS), it is the UAS Northwestern Switzerland that has the most frequent informational, infrastructure-related, and research-related transfer contacts among UAS. Eastern Switzerland also has an above-average record as regards education-related contacts.

Table 3.7: Percentage of firms that pursue KTT activities with partners of a certain group of science institutions according to the main form of KTT activities

Science Institutions	Information	Infrastructure	Education	Research	Consulting
ETH Domain					
ETH Zurich	46.0	15.5	15.9	6.9	15.7
EPFL	44.2	9.9	13.2	13.2	19.4
PSI)	52.6	7.8	18.1	9.5	12.1
EAWAG	56.5	13.0	17.4	7.2	5.8
EMPA	36.5	7.2	26.1	17.9	12.3
WSL	71.4	7.1	17.9	0.0	3.6
Cantonal Universities					
Berne	57.8	19.6	7.8	6.9	7.8
Basle	48.5	18.2	12.1	9.1	12.1
Fribourg	51.7	15.5	8.6	12.1	12.1
Geneva	52.4	23.8	11.9	4.8	7.1
Lausanne	64.1	15.4	10.3	5.1	5.1
Neuchâtel	56.1	12.2	12.2	7.3	12.2
St.Gallen	40.9	30.6	19.9	1.6	7.0
Italian Switzerland	54.5	4.5	13.6	9.1	18.2
Zurich	55.5	16.8	12.4	6.6	8.8
Universities of Applied Sciences					
Berne	44.8	23.0	13.9	9.1	9.1
Northwestern Switzerland	43.7	22.1	12.7	7.5	14.1
Eastern Switzerland	44.7	21.3	20.0	5.3	8.7
Central Switzerland	39.3	25.0	16.4	10.0	9.3
Western Switzerland	38.4	20.9	15.1	11.6	14.0
Italian Switzerland	44.9	14.3	14.3	12.2	14.3
Zurich	44.7	18.0	14.9	7.5	14.9

The figures in every *line* add up to 100%.

Differences between ETH Zurich and EPFL

According to the results in Table 3.6, ETH Zurich was able to increase its overall transfer contacts after 2005, while the transfer contacts with EPFL stagnated. However, the above discussion of the figures in Table 3.7 and 3.8 offers some explanation for this difference. There are clearly great differences between the two institutions in terms of informational contacts on the one hand and research contacts on the other hand.

Table 3.8: Percentage of firms with KTT activities in a certain main form according to science institution

Science Institutions	Information	Infrastructure	Education	Research	Consulting
ETH Domain					
ETH Zurich	16.1	14.8	15.9	12.4	20.6
EPFL	8.1	4.9	6.9	12.4	13.3
PSI	4.6	1.8	4.5	4.2	4.0
EAWAG	2.9	1.8	2.6	1.9	1.1
EMPA	8.7	4.7	17.8	22.0	11.0
WSL	1.5	0.4	1.1	0.0	0.3
Cantonal Universities					
Berne	4.4	4.1	1.7	2.7	2.3
Basle	2.4	2.5	1.7	2.3	2.3
Fribourg	2.3	1.8	1.1	2.7	2.0
Geneva	1.7	2.0	1.1	0.8	0.8
Lausanne	1.9	1.2	0.9	0.8	0.6
Neuchâtel	1.7	1.0	1.1	1.2	1.4
St.Gallen	5.7	11.7	7.9	1.2	3.7
Italian Switzerland	0.9	0.2	0.6	0.8	1.1
Zurich	5.7	4.7	3.6	3.5	3.4
Universities of Applied Sciences					
Berne	5.6	7.8	4.9	5.8	4.2
Northwestern Switzerland	7.0	9.6	5.8	6.2	8.5
Eastern Switzerland	5.0	6.6	6.4	3.1	3.7
Central Switzerland	4.1	7.2	4.9	5.4	3.7
Western Switzerland	2.5	3.7	2.8	3.9	3.4
Italian Switzerland	1.7	1.4	1.5	2.3	2.0
Zurich	5.4	5.9	5.2	4.6	6.8

The figures in every *column* add up to 100%.

Informational contacts are more frequent at ETH Zurich, while research contacts are more frequent at EPFL. The specific language situation in Switzerland might be a reason for this since most of the sample firms are located in the German-speaking area and hence might have difficulties calling French-speaking EPFL. Furthermore, a great number of firms are working in the large machinery sector, and ETH Zurich is more specialised in machinery compared to ETH Lausanne, while EPFL is more strongly specialised in electronics/instruments. Therefore it is not surprising that ETH Zurich has considerably more informational contacts and consequently more transfer contacts in total compared to EPFL.

As already mentioned ETH Zurich and EPFL have equal shares of research-related contacts, though ETH Zurich has almost twice as many personnel and resources. Since language

barriers are of minor importance for common research projects compared to informational requests, this result also fits to the explanation.

3.5 Technological fields of KTT-active and R&D-active firms

Table 3.9 shows the technological profile of KTT-active firms and firms with R&D activities. *KTT-active firms are most frequently found in "software, simulation, artificial intelligence" followed by "environmental technologies" and "new materials", and "energy technologies".* This clearly mirrors the technological profile of R&D-active firms. However, there are some technological fields that have a comparably greater percentage of KTT-active firms than R&D-active firms. Such a greater affinity to technology transfer can be found in the field of "nanotechnology", "biotechnology", "medical technology", "transport technology", and "energy technology".

Table 3.9: Technological fields of activities

	Percentage of firms with KTT	*Percentage of firms with R&D*
Nanotechnology	2.9	2.8
New materials	22.7	27.4
Microelectronics / semiconductor technology	5.3	10.5
Laser technology /optoelectronics / displays	7.8	11.9
Software / simulation / artificial intelligence	38.4	41.9
Telecommunication / information technology	15.9	19.8
Biotechnology / gene technology	3.6	2.1
Medical technology / sanitary engineering	13.9	10.8
Flexible computer-integrated manufacturing technology	11.7	16.3
Transport technology / traffic engineering / logistics	19.4	16.5
Energy technologies	22.6	21.7
Environmental technologies	33.1	31.4
Geological technologies	4.7	4.8
Mathematical models of finance	1.7	4.6

3.6 Mediating Institutions

From the point of view of firms, the relevance of all five types of KTT-mediating institutions has increased since 2002-2004, but it is still only a small number of KTT-active firms that seem to be aware of the mediating services of these institutions (Table 3.10). However, the Innovation Promotion Agency (CTI) is the most important institution, especially for medium-sized high-tech manufacturing firms. Transfer offices are next in importance, particularly small firms and/or firms in modern services emphasised their usefulness. The Swiss national Science Foundation (SNSF), European Framework Programmes, and other EU research programmes are less important, especially among small (except SNSF) and medium-sized firms. For large firms, EU Framework Programmes and other EU programmes are of similar importance to the transfer offices.

Table 3.10: Importance of single mediating institutions; percentage of firms reporting 4 or 5 on a five-point Likert scale (1: "not important"; 5: very important") according to sector, subsector and firm size class

	Transfer offices	Innovation Promotion Agency (CTI)	Swiss National Science Foundation (SNSF)	EU Framework Programmes	Other EU Research Programmes
Sectors					
Manufacturing	12.2	20.6	4.6	5.9	3.4
Construction	1.0	12.9	0.0	1.0	1.0
Services	14.3	18.5	7.0	6.6	6.7
Subsectors					
High-tech	12.3	24.7	5.9	8.2	5.0
Low-tech	12.0	13.0	2.3	1.9	0.6
Modern services	16.2	20.9	7.6	8.1	8.3
Traditional services	6.0	7.7	4.4	0.0	0.0
Size					
Small (5-49 empl.)	15.1	15.9	8.0	7.9	6.5
Medium (50-249 empl.)	9.6	24.0	2.6	1.8	1.9
Large (> 250 empl.)	10.5	21.5	3.2	10.2	9.5
Total 2011	*12.9*	*19.0*	*5.8*	*6.1*	*5.3*
Total 2005	*9.5*	*11.0*	*3.6*	*3.2*	*1.5*

3.7 Motives for KTT activities

Table 3.11 shows the main motives for transfer activities from the firms' perspective in comparison with the 2005 survey. *There are no discernible differences between the two periods.*

"Access to human capital" is by far the most important motive for technology transfer with universities, followed by "financial motives", "access to research results", and "institutional motives" (Table 3.12). Not surprisingly, the most important single motives are "further education, training possibilities", "access to human capital", and "recruitment of graduates". All other human capital related motives are among the top categories. "Project characteristics require cooperation", "access to research results for developing new processes", and "access to research results for developing new products" are motivating factors of medium importance. However, access to human capital dominates the motive profile of transfer-active firms.

Table 3.11: Main categories of motives for KTT activities; percentage of KTT-active firms pursuing a certain category of motives by sector, subsector and firm size class(*)

	Access human capital ("tacit knowledge")	Access research results ("codified knowledge")	Financial motives	Institutional/ organisational motives
Total 2011	*65.1*	*28.9*	*33.0*	*28.1*
Total 2005	*65.9*	*29.3*	*41.1*	*25.0*

(*): Firms reporting 4 or 5 on a five-point Likert scale (1: "not important"; 5: very important") for any *single* motive in a certain main group of motives.

Table 3.12: Main categories of motives and single motives for KTT activities; percentage of firms with KTT activities

Single motives(*) / main groups of motives(**)	
Access to human capital ("tacit knowledge")	*65.1*
Access to specific skills in addition to internal know-how	40.3
New research ideas	16.9
Further education, training possibilities	44.8
Recruitment of graduates	36.0
Access to basic research	16.4
Access to research results ("codified knowledge")	*28.9*
Access to patents/licences	2.3
Access to research results for subsequent internal use	11.2
Access to research results for developing new products	16.1
Access to research results for developing new processes	17.7
Access to R&D infrastructure	8.3
Financial motives	*33.0*
Cost-saving in R&D	9.9
Reduction of technical R&D risks	10.8
Time-saving in R&D	15.7
Insufficient firm R&D resources	11.3
Project characteristics require cooperation with scientific institutions	21.7
Institutional /organisational motives	*28.1*
Building up a new research field	2.2
R&D outsourcing as a strategic measure	6.1
R&D cooperation as a condition for public funding	15.1
Improvement of firm image through co-operation with scientific institutions	12.6
Indirect access to competitors' knowledge	5.1

(*): Firms reporting 4 or 5 on a five-point Likert scale (1: "not important"; 5: "very important") for a certain *single* motive; (**): Firms reporting 4 or 5 on a five-point Likert scale for any *single* motive in a certain main group of motives.

3.8 Impact of KTT activities

Although "access to human capital" provides the greatest motivation for transfer activities, the greatest impact refers to the "development of new processes" and "development of new products", i.e., "knowledge exploitation" outcomes, followed by "recruitment" and "further education" (Table 3.13). New processes are predominantly developed by large firms in the modern service sector, while new products are most frequently the result of transfer activities for large high-tech manufacturing firms. Interestingly, it proved that most frequently it is large firms that detect the positive impacts of transfer activities of all investigated kinds. "*Initiation of new innovation projects" ("knowledge exploration" outcomes) is seen to be considerably less frequent than "knowledge exploitation" outcomes.*

Table 3.13: Impact of KTT activities; percentage of firms with KTT activities according to sector, sub-sector and firm size class

	Initiation of new innovation projects	Develop-ment of new products	Develop-ment of new processes	Scientific publica-tions	Patents	Licenses	Human capital: recruit-ment	Human capital: further education
Sectors								
Manufacturing	31.6	48.3	38.7	18.1	13.5	3.8	37.1	24.2
Construction	15.0	26.8	41.8	8.0	1.0	1.0	20.9	9.0
Services	18.0	35.5	51.4	22.4	4.8	4.1	39.5	37.7
Subsectors								
High-tech	34.8	49.7	34.4	19.8	18.1	3.1	43.2	24.7
Low-tech	25.8	45.6	46.4	15.0	5.3	5.1	26.2	23.3
Modern services	15.2	28.8	52.6	25.9	5.5	4.7	39.5	41.8
Traditional services	30.3	65.3	45.7	6.9	1.7	1.7	39.7	19.3
Size								
Small (5-49 empl.)	16.0	38.6	50.0	23.1	4.9	4.3	27.2	33.0
Medium (50-249 empl.)	30.0	37.8	38.1	10.9	9.0	1.5	51.6	25.8
Large (> 250 empl.)	43.7	55.9	51.2	34.7	24.0	9.9	58.7	41.8
Total	*22.9*	*39.8*	*46.3*	*20.1*	*7.8*	*3.9*	*37.8*	*31.4*

3.9 Obstacles to KTT activities

Are there factors that impede KTT activities between firms and universities? Are there problems on the part of the enterprises or on the part of the universities?

All the firms were asked to assess the importance of 26 different possible single obstacles to KTT activities on a five-point Likert scale ranging from 1 ("not important") to 5 ("very important"). The 26 different obstacles were pooled into five main groups of obstacles, i.e. "lack of information", "firm deficiencies", "deficiencies of science institutions", "costs, risks, uncertainty", and "institutional/organisational obstacles". We used the share of firms reporting 4 or 5 on a five-point Likert scale for any of the single obstacles in a certain group of obstacles to characterise the overall importance of this group of obstacles.

Table 3.14: Main categories of obstacles to KTT activities; percentage of all firms perceiving a certain category of obstacles as important according to sector, sub-sector and firm size class(*)

	Lack of information	Firm deficiencies	Deficiencies of science institutions	Costs/risks/ uncertainty	Organisational/ institutional obstacles
Sectors					
Manufacturing	27.8	50.4	39.6	43.4	30.3
Construction	22.3	50.2	39.9	37.7	24.4
Services	25.0	55.1	43.2	44.2	33.3
Subsectors					
High-tech	31.5	47.5	42.4	49.6	35.4
Low-tech	25.3	52.5	37.6	39.1	26.9
Modern services	20.7	53.5	38.2	43.5	29.6
Traditional services	30.7	57.2	49.7	45.3	38.3
Size					
Small (5-49 empl.)	25.6	53.4	40.9	42.6	30.2
Medium (50-249 empl.)	24.1	52.0	44.2	43.0	31.7
Large (> 250 empl.)	20.9	39.4	37.8	38.3	31.6
Total 2011	*25.2*	*52.7*	*41.4*	*42.6*	*30.5*
Total 2005	*24.1*	*49.2*	*42.0*	*42.4*	*24.5*

(*): Percentage of firms reporting 4 or 5 on a five-point Likert scale (1: "not important"; 5: very important") for any of the single obstacles in a certain main group of obstacles.

Table 3.14 compares the obstacle profile of firms from the 2005 survey with the results from the 2011 survey. *Only small differences can be detected over time: "firm deficiencies",*

obstacles related to costs and risks and "deficiencies of science institutions" are still the most important categories of obstacles. There are minor differences among sectors, subsectors, and firm size classes. However, it can be argued that large firms do perceive transfer obstacles less frequently (exception: institutional obstacles) as compared to other firm size classes.

Table 3.15 looks at single obstacles and compares the profile of KTT-active firms, KTT-inactive firms, and all firms. "Firm deficiencies" are most frequently perceived as a category of severe impediments to KTT activities with science institutions (53% of all firms). "Firm's research questions not being interesting for science institutions" and "lack of interest for scientific projects" are the most frequently reported single obstacles in this category, about the same percentages as in the 2002-2004 period. The obstacle categories "cost, risks, uncertainty" and "deficiencies of science institutions" are somewhat less important than "firm deficiencies". Finally, the "lack of information" and institutional or organisational obstacles are a severe problem only for 25% and 31% of all firms, respectively.

The obstacle profile described above reflects to a large extent also the obstacle profile of KTT-inactive firms. However, there are differences compared to KTT-active firms. KTT-active firms are predominantly prevented from intensifying their KTT activities through "cost, risks, uncertainty"-related obstacle categories, followed by "firm deficiencies" and "deficiencies of science institutions" (see section 4.2 for a more in-depth analysis of the obstacles that effectively hamper KTT activities).

With regard to single obstacle categories, it can be seen that for "all firms" and "no KTT" firms, the top three obstacles are "firms' R&D questions are not interesting for science institutions", "lack of financial resources to transfer activities", and "R&D orientation of science institutions is uninteresting for firms". For firms with KTT activities there is a similar profile; however, the order is slightly different (1. "lack of financial resources"; 2. "firms' R&D questions are not interesting for science institutions") and "lack of qualified staff" are among the top three obstacles as well. The obstacle "R&D orientation of science institutions is uninteresting for firms" is not a very important obstacle for transfer-active firms.

It is also worth noting that KTT-active firms have a less intense perception of all obstacles compared to KTT-inactive firms and the category "all firms".

Table 3.15: Main categories of obstacles and single obstacles: firms with/without KTT activities

Obstacles to KTT activities	KTT	No KTT	All firms
LACK OF INFORMATION	*21.6*	*26.1*	*25.2*
Difficulty getting information about R&D in science institutions	11.3	20.0	18.2
Difficulty finding contact persons	15.3	20.6	19.5
Lack of resources for "interface" (e.g. transfer office)	7.3	18.7	16.3
FIRM DEFICIENCIES	*43.3*	*55.2*	*52.7*
Lack of qualified staff	21.8	21.8	21.8
Lack of technical equipment	10.2	20.3	18.2
Lack of interest in scientific projects	10.2	34.5	29.4
Firms' R&D questions are not interesting for science institutions	25.4	43.6	39.8
DEFICIENCIES OF SCIENCE INSTITUTIONS	*36.7*	*42.7*	*41.4*
Lack of scientific staff for transfer activities	4.6	19.1	16.1
Lack of entrepreneurial spirit	13.9	17.7	16.9
R&D orientation of science institutions is uninteresting for firms	18.4	33.9	30.7
Possible R&D results cannot be commercialised	19.9	30.4	28.2
COST, RISKS, UNCERTAINTY	*44.3*	*42.1*	*42.6*
Secrecy with respect to firms' know-how is not guaranteed	14.7	17.8	17.1
Need for comprehensive additional follow-up work in order to implement public R&D results	19.3	19.9	19.8
Lack of firm financial resources for transfer activities	25.9	33.9	32.2
Science institutions' lack of financial resources for cooperation on an equal basis with firms	13.0	21.8	19.9
Insufficient efficiency of university staff compared to firms' staff	10.5	17.9	16.3
Technological dependency on external institutions	8.2	15.9	14.3
Uncertainty about outcomes of cooperation	13.1	20.7	19.1
INSTITUTIONAL/ORGANISATIONAL OBSTACLES	*31.1*	*30.4*	*30.5*
Costly administrative and approval procedure	18.3	24.4	23.1
Lack of administrative support for joint R&D projects on the university's part	10.2	17.2	15.7
Lack of administrative support for the commercialisation of R&D outcomes on the university's part	7.6	17.2	15.1
Problems with property rights	9.6	17.4	15.8
Problems with project management at universities (e.g. communication problems)	7.0	18.0	15.7
Different understanding of priorities	14.4	19.3	18.3
Lack of trust on the firm's part	4.6	15.9	13.5
Risk of losing reputation on the firm's part	1.1	15.3	12.3

Main groups of obstacles: Percentage of firms reporting 4 or 5 on a five-point Likert scale (1: "not important"; 5: very important") for any of the single obstacles in a certain main group of obstacles. Single obstacles: Percentage of firms reporting 4 or 5 on a five-point Likert scale (1: "not important"; 5: very important").

4. Drivers of KTT activities

4.1 Model of the determinants of KTT activities

This part-study explores the factors determining the propensity of Swiss firms to interact with public science institutions in Switzerland (universities and other research institution), i.e. to get involved in KTT activities in order to gain new scientific knowledge in research fields which are relevant for their own activities. We are especially interested in the different forms of this interaction, not only through joint research projects but also through training, recruitment of qualified R&D personnel, jointly supervised master theses and PhDs, consulting and so on (see Arvanitis et al. 2011 for a similar study based on the data of the KTT survey 2005).

A first group of determinants is related to the resource endowment of the enterprises with human capital, physical capital and knowledge capital. It is expected that particularly firms with high human capital and knowledge capital intensity leading to a high knowledge absorptive capacity would possess the profile needed for KTT activities with science institutions. Such firms would be most frequently found in high-tech manufacturing (e.g,. pharmaceutical industry, electronics) and in knowledge-based service industries (e.g., software industry). Physical capital intensity would be a complementary measure for absorptive capacity especially for manufacturing firms.

Further firm characteristics which we expect to be related to KTT activities are the degree of exposition to international competition (positively; higher know-how requirements for international oriented firms), firm size (positively; possible existence of scale effects with respect to the utilization of scientific knowledge), firm age (positively; older firms possess a longer experience in cooperation); status as a subsidiary of a foreign mother-company (a priori not clear effect).

The propensity to engage in KTT activities is also influenced by the field(s) of technology, in which a firm is active. Given its technological profile a firm intending to get involved in KTT activities would have to consider the costs of this involvement. Possible costs would include high transaction costs due to deficiencies on the interface between firm and science institution either on the side of the firm or the side of the science institution, great information asymmetries, great financial risks due to the uncertainty of research outcomes, property rights problems and costs of possibly arising technological dependence from science partner.

Table 4.1 shows the detailed model specification of our model of the determinants of KTT propensity. As *dependent* variables we used not only the binary variable KTT (KTT-activities in the period 2008-2010 yes/no) but also five further binary variables for each of the five main forms of KTT activities (variables INFO; EDUC; REAS; INFR; and CONS).

Table 4.1: Definition and measurement of model variables

Variable	Definition / measurement
Dependent variables	
KTT	Knowledge and technology transfer activities in the period 2008-2010 yes/no
INFO	3 variables for single forms of KTT activities referring to informal contacts, attendance of conferences, workshops of science institutions, etc. measured on a five-point Likert scale (1: not important"; 5: "very important") were combined to one dummy variable: value 1 is attached to firms that reported a value 4 or 5 for any of the three original variables, value 0 to those firms reporting 1, 2 or 3 for any of the three original variables; see table 2 for details for the single forms.
EDUC	Similar construction as INFO based on 9 single variables referring to education and training activities (see Table 3.4)
REAS	Similar construction as INFO based on 3 single variables referring to research activities (see table 3.4)
INFR	Similar construction as INFO based on the variables for two single forms of KTT referring to technical infrastructure (see Table 3.4)
CONS	Similar construction as INFO based on 2 single variables referring to consulting activities (see Table 3.4)
Independent variables	
LQUAL	Natural logarithm of the share of employees with tertiary-level education
LCL	Natural logarithm of gross investment per employee
LEXP	Natural logarithm of exports divided by sales (export intensity)
LAGE	Natural logarithm of firm age (number of years since foundation: year of survey minus founding year of the firm)
RD	R&D activities yes/no
FOREIGN	Foreign-owned firm yes/no
Main groups of obstacles:	
- Firm deficiencies	Binary variable for 'firm deficiencies': if the average score of the 4 single obstacles that belong to the main group 'firm deficiencies' (see Table 3.15) > 4, then the binary variable for 'firm deficiencies' gets the value 1, otherwise 0
- Organizational / institutional obstacles	Binary variable for 'organizational / institutional obstacles: similar construction based on 8 single obstacles (see Table 3.15)
Single obstacles:	
See Table 4.4	Binary variables for single obstacles: for the values 4 or 5 measured on a Likert scale (1: 'not important'; 5: 'very important'); otherwise 0

The metric variables refer to the year 2010; the qualitative variables refer to the 3-year period 2008-2010.

4.2 Econometric method

Due to the binary character of the dependent variable KTT a probit model was estimated. In a further step, we investigated the possibility of the existence of a selectivity bias due to the fact that for the estimates of the variables for the five specific forms of KTT activities only the firms with KTT activities can be taken into consideration. To this end, we estimated a Heckman selection model for each of the five dependent variables referring to specific forms of KTT activities. In four cases the two equations were not significantly correlated (10% test level for LR test), therefore the existence of a selectivity bias can be excluded. As a consequence the estimates of probit models for these variables are presented in Table 4.2. In one case (variable EDUC) selectivity bias could not be excluded. Table 4.3 contains the estimates of a simultaneous probit model for EDUC (including a selection equation for KTT; STATA procedure 'heckprob')

Table 4.2 contains the estimates for the binary variable KTT, in a model version that takes *technological fields* into consideration but not obstacles of KTT. The same model version is estimated also for the five KTT forms (Table 4.3). In a second model version we investigated the influence of KTT obstacles on KTT is investigated (Table 4.4).

Since the results are only cross-section estimates, it is not possible to test directly the existence of causal relations between the independent variables, particularly KTT, and the dependent variables. Nevertheless, some robust regularities emerge, which, if interpreted in view of our main hypothesis, could indicate the direction of causal links.

4.2 Results of the econometric estimations

Overall propensity to KTT activities

The variables for human capital intensity and the propensity to R&D activities have highly significant positive coefficients. Both variables are closely related to a firm's ability to absorb new knowledge from its environment. These two variables show also the largest marginal effects. Also capital intensity, the third variable in our model referring to firms' resource endowment, is also relevant for distinguishing between firms with KTT activities and those without this type of activities.

Export intensity taken as a measure of a firm's degree of exposition to international competition shows also a significantly positive effect, which is much smaller than that for human capital, R&D intensity and capital intensity. The variable for firm age has a significantly positive coefficient, thus indicating that older firms are stronger inclined to get involved in KTT activities than younger ones, presumably because they have a greater experience in co-operating with science institutions than younger ones. There is a significant difference between domestic and foreign firms with respect to KTT activities: foreign-owned firms seem to be less inclined to cooperation with domestic science institutions than domestic

firms.[6] Finally, there is a positive non-linear relationship between firm size and the propensity to KTT activities. Larger firms appear to be stronger inclined to KTT activities than smaller firms.

Firms with KTT activities seem to have a focus on biotechnology/gene technology, nanotechnology, new materials, software/simulation/artificial intelligence and environmental technologies (in decreasing ranking order as to marginal effects). For all other technological fields in Table 4 no differences could be found between KTT-active firms and firms without KTT activities. For telecommunication/information technology a negative effect is found, indicating that R&D in these fields is conducted primarily in the firms' own R&D departments.

Table 4.2: Determinants of the propensity to get engaged in KTT activities

Explanatory variables	Marginal effect	Standard error
LQUAL	0.048***	(0.011)
LCL	0.015***	(0.005)
RD	0.082**	(0.011)
LEXP	0.012**	(0.006)
LEMPL	0.047***	(0.006)
LAGE	0.023*	(0.012)
FOREIGN	-0.056**	(0.024)
Technology fields		
Nanotechnology	0.102*	(0.053)
New materials	0.073***	(0.023)
Microelectronics / semiconductor technology	-0.056	(0.038)
Laser technology /optoelectronics / displays	0.048	(0.038)
Software / simulation / artificial intelligence	0.068***	(0.023)
Telecommunication / information technology	-0.058**	(0.027)
Biotechnology / gene technology	0.179***	(0.071)
Medical technology / sanitary engineering	0.016	(0.033)
Flexible manufacturing technology	-0.022	(0.027)
Transport technology / traffic engineering / logistics	-0.006	(0.027)
Energy technologies	0.043	(0.028)
Environmental technologies	0.041*	(0.023)
Geological technologies	0.091	(0.069)
N	1758	
Pseudo R2	0.267	
Wald chi2	446.9***	

Probit estimates; ***, ** and * denote statistical significance at the 1%-, 5%- and 10%-test level respectively; heteroskedasticity-robust standard errors (White-procedure); controls for 22 industries (reference industry: food/beverage; reference technology field: mathematical finance models.

[6] The effects of LCL, LEXP and FOREIGN showed the same signs but were statistically insignificant in a similar estimation based on the 2005 data; see Arvanitis et al. 2011).

Propensity to specific forms of KTT activities

While in the estimates for KTT firms with KTT activities are compared with firms that are not engaged in such activities, in the case of the five specific KTT forms firms with a strong engagement in one type of activities are compared with firms showing a strong engagement in any of the other four types of activities. Thus, the results in Table 4.3 show a pattern of explanation that differs in some aspects from that for the variable KTT. Particularly, the variables for resource endowment are not equally important for all five *specific* forms of KTT activities.

The human capital intensity is relevant for educational and as well as for informal informational contacts but not for consulting or infrastructure-oriented activities and – rather astonishingly for research activities. The existence of R&D activities is particularly relevant for research, educational and infrastructure-oriented activities. Firms with high export intensity show a specific interest for research, educational and infrastructure activities. The capital intensity effects can be traced back to firms with a stronger focus on infrastructure and educational activities, the effect of foreign-owned firms can be traced back primarily to firms focusing to educational activities (foreign firms being less acquainted with the domestic system of higher education than domestic firms). The propensity to research activities appears to be higher for younger firms – contrary to the overall firm age effect in Table 4.2. Finally, the positive effect of firm size is more relevant for educational and research activities.

We found an interesting pattern with respect to the relative importance of the five main forms of KTT activities for the different technological field taken into consideration in this study. For each of the 5 main forms of KTT activities only the technologies are shown, which have positive and statistical significant coefficient:

INFO: nanotechnology, energy technologies; INFRO: laser technology/optoelectronics/ displays; energy technologies; EDUC: new materials; software/simulation/artificial intelligence; biotechnology/gene technology; geological technologies; REAS: biotechnology/ gene technology; energy technologies; geological technologies; CONS: laser technology/ optoelectronics/ displays; flexible manufacturing technology; energy technologies. Firms with a focus on educational and/or research activities are engaged in similar fields. Energy technologies seem to be a relevant technological field for all five categories of KTT activities. For all other technologies not mentioned above no differences among the firms pursuing different forms of KTT activities are discernible.

Table 4.3: Determinants of the propensity to get engaged in different f*orms* of KTT-activities

Explanatory variables	INFO	INFR	EDUC	REAS	CONS
LQUAL	0.174***	0.060	0.506***	0.045	0.121
	(0.089)	(0.103)	(0.130)	(0.122)	(0.092)
LCL	-0.005	0.223**	0.102*	0.023	-0.066
	(0.047)	(0.101)	(0.060)	(0.063)	(0.086)
RD	-0.016	0.096*	0.413***	0.391***	0.079
	(0.085)	(0.058)	(0.111)	(0.111)	(0.051)
LEXP	-0.006	0.091*	0.104*	0.118*	-0.030
	(0.044)	(0.055)	(0.056)	(0.061)	(0.046)
LEMPL	0.070	-0.029	0.223***	0.173**	0.069
	(0.046)	(0.055)	(0.052)	(0.059)	(0.049)
LAGE	0.018	0.064	-0.053	-0.273***	0.051
	(0.089)	(0.098)	(0.097)	(0.105)	(0.091)
FOREIGN	-0.127	-0.230	-0.352*	-0.134	-0.085
	(0.161)	(0.191)	(0.194)	(0.201)	(0.173)
Technology fields					
Nanotechnology	0.688**	0.326	-0.118	0.197	-0.071
	(0.276)	(0.254)	(0.285)	(0.286)	(0.253)
New materials	0.183	0.117	0.386**	0.134	-0.129
	(0.146)	(0.167)	(0.176)	(0.188)	(0.150)
Microelectronics / semiconductor technology	-0.207	-0.040	0.235	0.204	-0.118
	(0.221)	(0.220)	(0.213)	(0.253)	(0.232)
Laser technology /optoelectronics / displays	0.437	0.378*	-0.094	-0.096	0.392*
	(0.229)	(0.226)	(0.251)	(0.273)	(0.224)
Software / simulation / artificial intelligence	0.103	0.130	0.446***	0.141	0.245
	(0.142)	(0.158)	(0.164)	0.175	(0.155)
Telecommunication / information technology	-0.069	0.005	-0.057	0.025	0.105

	(0.176)	(0.190)	(0.191)	(0.217)	(0.184)
Biotechnology / gene technology	0.153	0.419	0.730**	0.670**	0.386
	(0.319)	(0.306)	(0.344)	(0.321)	(0.309)
Medical technology / sanitary engineering	0.151	-0.134	0.139	0.088	0.112
	(0.193)	(0.216)	(0.208)	(0.239)	(0.195)
Flexible manufacturing technology	0.058	0.257	0.234	0.296	0.365**
	(0.161)	(0.182)	(0.185)	(0.201)	(0.166)
Transport technology / traffic engineering / logistics	-0.306*	-0.076	-0.362*	-0.083	0.128
	(0.171)	(0.208)	(0.214)	(0.230)	(0.173)
Energy technologies	0.321*	0.448**	0.388**	0.397*	0.384**
	(0.180)	(0.188)	(0.192)	(0.209)	(0.181)
Environmental technologies	-0.048	-0.328*	0.214	-0.127	-0.159
	(0.157)	(0.194)	(0.180)	(0.204)	(0.174)
Geological technologies	0.529	0.408	0.894**	1.513***	0.022
	(0.455)	(0.431)	(0.398)	(0.418)	(0.412)
N	469	469	450	469	469
Pseudo R2	0.079	0.140	-	0.209	0.068
Wald chi2	51.1***	58.9***	140.4***	92.5***	40.3**

Probit estimates (INFO; INFR; REAS; CONS); heckprob-estimates (EDUC); ***, ** and * denote statistical significance at the 1%-, 5%- and 10%-test level respectively; heteroskedasticity-robust standard errors (White-procedure; probit estimates); controls for 4 subsectors (reference sector: construction or low-tech manufacturing; reference technology field: mathematical finance models.

The role of KTT obstacles

We estimated versions of the basic model for overall KTT activities, in which obstacle variables were added to the independent variables in Table 4.2 in order to investigate the influence of such impediments of KTT activities on a firm's propensity to get engaged in such activities. We expected negative effects for those obstacles that effectively hamper KTT activities. Table 4.4 contains the results with respect to the obstacle variables based on 11 model estimates, one for each of the tested obstacle variables. The obstacle variables were separately tested because of high multicollinearity due to the fact that firms reported high importance for several obstacles at the same time. Here are presented only the results for those obstacles with significantly negative effects. To keep the table short also all other model variables are omitted in Table 4.4.

In Table 4.4 contains besides the marginal effects also the percentage of all firms reporting 'high importance' for the respective main groups of obstacles or single obstacles. 'Firm deficiencies' was one main group of obstacles that shows a significantly negative effect.[7] This is the most important group of obstacles. This is demonstrated not only by the fact that more than 50% of all firms reported such impediments as 'very important' (see column 3 in Table 4.4) but also by the estimates for every single obstacle in this group. Two out of four single obstacles in this group show relatively large marginal effects that are statistically significant and negative, namely the obstacles 'firms' questions are not interesting for science institutions' ('very important' for 40% of firms) and 'lack of interest in scientific projects' (30% of firms). Even if the main group 'deficiencies of science institutions' as a whole does not yield a significant effect, two out of four single obstacles in this group show significantly negative effects, namely the obstacles 'lack of scientific staff for transfer activities' (16% of all firms) and 'possible results cannot be commercialized' (28% of all firms).[8] The former obstacle yields a relatively large marginal effect.

The second main group of obstacles for which a negative effect was found is the group 'organizational and/or institutional obstacles', whereas the marginal effect is significantly smaller than in the case of 'firm deficiencies'. The underlying two single obstacles, to which the overall effect may be traced back, are the obstacles 'lack of administrative support of the commercialisation of R&D outcomes on part of the university' (about 16% of firms) and 'risk loosing reputation on part of the firm' (about 12% of all firms).

Further, negative effects were found for the following single obstacles that belong to the other two main groups of obstacles: 'technological dependency from external institutions', 'uncertainty about outcomes of cooperation' (group 'costs/risks/uncertainty') and 'lack of resources for "interface" (e.g., transfer office)' (group: 'lack of information').

[7] This was the case in the respective study that was based on the 2005 data (see Arvanitis et al. 2011).
[8] The respective main group effect was significantly negative in the 2005 study.

On the whole, 9 out of 26 single obstacles appear to hamper effectively KTT activities. The most severe obstacles come from firms themselves. *Policy-relevant* are primarily those impediments that can be influenced by the behaviour of science institutions, namely those related with *deficiencies of science institutions.*

Table 4.4: Economic relevance of different obstacles

Main groups of obstacles	Marginal effects (*)	Standard error	Percentage of all firms reporting ‚high importance'
Firm deficiencies	-0.040***	0.010	52.7
Organizational / institutional obstacles	-0.020*	0.012	30.5
Single obstacles			
Lack of resources for "interface" (e.g. transfer office)	-0.081***	0.032	16.3
Lack of interest in scientific projects	-0.094***	0.023	29.4
Firms' R&D questions are not interesting for science institutions	-0.132***	0.019	39.8
Lack of scientific staff for transfer activities	-0.132***	0.034	16.1
Possible R&D results cannot be commercialised	-0.038*	0.023	28.2
Technological dependency from external institutions	-0.088**	0.039	14.3
Uncertainty about outcomes of cooperations	-0.083***	0.028	19.1
Lack of administrative support of the commercialisation of R&D outcomes on part of the university	-0.080*	0.042	15.7
Risk loosing reputation on part of the firm	-0.130**	0.062	12.3

(*): Marginal effects denote the magnitude of the effect of the respective variable in estimates of the probit model as in Table 4.2. ***, ** and * denote statistical significance at the 1%-, 5% and 10%-test level, respectively.

5. Impact of KTT activities on innovation and economic performance

5.1 Innovation and KTT activities

Conceptual background and model specification

Our main hypothesis is that KTT activities would improve the innovation performance of firms and also – either directly or indirectly via innovation output – their economic performance in the narrow sense; e.g,. average labour productivity (see Arvanitis et al. 2008b). The KTT effect on innovation performance could be traced back to an increase of technological opportunities anticipated by firms due to university-industry knowledge transfer. This would include effects from a wide palette of KTT activities such as exchanging scientific and technical information, various educational activities (e.g. recruitment of R&D personnel from the universities, joint PhDs, specialized training courses), consulting, use of technical infrastructure, and, of course, cooperation in research. The prominent role of technological opportunities as a major supply-side determinant of innovation is often emphasized in literature (e.g., Klevorick et al. 1995).

In order to analyse the relationship between KTT activities and measures of innovative performance we specified an innovation equation. Innovation performance is measured by the output variable LINNS (logarithm of the sum of the sales shares of *new* products and *considerably modified* products). We used as independent variables proxies for the intensity of physical capital (LCL), the degree of exposure to international competition (LEXP)**,** firm age (LAGE), the affiliation of the firm (FOREIGN; foreign firm yes/no), and firm size (LEMPL) (see Table 4.1 for the definition of the variables). According to standard empirical evidence from earlier studies we expected positive effects for LCL, LEXP, and LEMPL. The effect of the variable FOREIGN is not a priori clear. It is also not a priori obvious, if younger firms should be more innovative than older firms (variable LAGE).

According to our main hypothesis, we expect that the involvement in KTT activities (variable KTT) would strongly enhance firms' innovation performance.

Econometric method

We estimated a tobit model for the variable LINNS that is downward censored at 0. However, being involved in KTT activities is not exogenous to innovation activities. We accounted for this endogeneity effect by estimating a version of the innovation equation, in which the variable KTT was instrumented (instrument: obstacle 'firm deficiencies'). The predicted values of the KTT variable were then inserted in the innovation variable instead of the original KTT variable and bootstrapping was used in order to correct the standard errors.

Table 4.5: Effect of KTT-activities on the sales share of innovative products (LINNS)

Explanatory variables	Coefficient	Standard error
LQUAL	0.223***	(0.073)
RD	0.916***	(0.096)
LCL	0.060*	(0.034)
LEXP	0.118***	(0.045)
LEMPL	0.145***	(0.051)
LAGE	-0.143	(0.089)
FOREIGN	0.005	(0.180)
KTT	*0.448***	*(0.166)*
Technology fields		
Nanotechnology	-0.169	(0.368)
New materials	0.690***	(0.176)
Microelectronics / semiconductor technology	0.146	(0.285)
Laser technology /optoelectronics / displays	0.321	(0.289)
Software / simulation / artificial intelligence	0.731***	(0.179)
Telecommunication / information technology	0.421**	(0.202)
Biotechnology / gene technology	0.121	(0.520)
Medical technology / sanitary engineering	0.495**	(0.251)
Flexible manufacturing technology	0.520***	(0.200)
Transport technology / traffic engineering / logistics	0.277	(0.192)
Energy technologies	-0.496**	(0.219)
Environmental technologies	0.370**	(0.181)
Geological technologies	-0.137	(0.591)
N	1747	
N left censored	831	
Pseudo R2	0.135	
LR chi2	770.7***	

Tobit estimates; ***, ** and * denote statistical significance at the 1%-, 5%- and 10%-test level respectively; controls for 22 industries (reference industry: food/beverage); reference technology field: mathematical finance models.

Results of the econometric estimations

The variable reflecting the firms' resource endowment (LCL and LQUAL) have the expected positive sign and are highly significant. Positive is also as expected the effect of RD as innovation input. Further, we find a positive effect of the variable LEXP. No effects could be found for firm age (LAGE). Foreign-owned and domestic firms do not appear to be different as to innovation performance. Firm size is positively correlated with the innovation variable LINNS.

Last but not least, the variable KTT has also the expected positive sign and is highly significant. This is an important result emphasizing the relevance of KTT activities for a firm's innovation performance.

5.2 Productivity and KTT activities

Conceptual background and model specification

Our main hypothesis is that KTT activities would contribute as an additional production factor to an improvement of labour productivity of KTT-active firms compared to firms that are not involved in such activities. The overall positive KTT effect could be traced back to a *direct* link to productivity. Thus, we would expect a significantly positive coefficient for the KTT variable. This direct effect would include effects from a wide spectrum of KTT activities such as exchanging information, various educational activities (e.g., recruitment of R&D personnel, joint PhDs, specific training courses), consulting, use of technical infrastructure, and, of course, cooperation in research.[9] Behind this expectation is the idea that university knowledge would raise the effectiveness of R&D with respect to economic performance by complementing, not substituting for, in-house knowledge.

The dependent variable is the natural logarithm of value added per employee (average labour productivity). Besides the variable KTT we also used physical capital intensity (LCL), human capital intensity (LQUAL), export intensity (LEXP), firm size (LEMPL) and the variable FOREIGN as further independent variables in the productivity equation.

Econometric method

We estimate an Ordinary Least Squares (OLS) model. Also in this case we had to deal with the endogeneity issue with respect to the variable KTT. Also in this case we applied the procedure discussed in section 5.1 (instrument: obstacle 'firm deficiencies').

Results of econometric estimations

The variables for physical capital, human capital and export intensity show the expected positive and statistically significant coefficients. We could find no firm size effect but a positive effect for foreign-owned firms. Finally, we could not find a significant effect for the variable KTT. KTT activities do not seem to impact directly productivity. There is a positive indirect effect through innovation performance that exercises itself a positive influence on labour productivity.

[9] We further expect that there is also an *indirect* effect of KTT activities channelled through the firms' innovative activities that are strongly enhanced by such activities (see Arvanitis et al. 2008b). We do not investigate this indirect effect here.

Table 4.6: Effect of KTT-activities on average labour productivity (LQL)

Explanatory variables	Coefficient	Standard error
LQUAL	0.072***	(0.013)
LCL	0.027***	(0.006)
LEXP	0.019**	(0.008)
LEMPL	0.006	(0.012)
FOREIGN	0.194***	(0.040)
KTT	*0.018*	*0.032*
Technology fields		
Nanotechnology	0.011	(0.067)
New materials	0.055**	(0.033)
Microelectronics / semiconductor technology	-0.014	(0.044)
Laser technology /optoelectronics / displays	-0.026	(0.054)
Software / simulation / artificial intelligence	0.009	(0.032)
Telecommunication / information technology	0.012	(0.038)
Biotechnology / gene technology	0.078	(0.111)
Medical technology / sanitary engineering	0.024	(0.037)
Flexible manufacturing technology	-0.079**	(0.034)
Transport technology / traffic engineering / logistics	0.044	(0.033)
Energy technologies	-0.043	(0.028)
Environmental technologies	-0.121***	(0.037)
Geological technologies	-0.009	(0.112)
N	1820	
R2	0.471	
F	9.7***	

OLS estimates; ***, ** and * denote statistical significance at the 1%-, 5%-and 10%-test level respectively; heteroskedasticity-robust standard errors (White-procedure); controls for 22 industries (reference industry: food/beverage); reference technology field: mathematical finance models.

6. Exploitation versus exploration: For what purpose do firms acquire university knowledge?

6.1 Conceptual background and model specification

The main idea

The central idea of this chapter comes from the seminal paper of March (March 1991), in which the potential trade-off between exploitation and exploration as to alternative investment opportunities is analyzed. As this author puts it, "choices must be made between gaining new information about alternatives and thus improving future returns (which suggests allocating part of the investment to searching among uncertain alternatives), and using the information currently available to improve present returns (which suggests concentrating the investment on the apparently best alternative) (p. 72). Cohen et al. (2002) applied this concept on the knowledge acquired by firms by distinguishing between external information sources that are rated by firms as an important stimulus to the "initiation of new projects" (e.g., public research) and such external sources of information that contribute to "R&D project completion" (e.g., clients). In this study we apply this distinction specifically to knowledge acquired from science institutions (see also Broström and McKelvey 2009 for a similar application for Swedish manufacturing firms). We want to find out which type of firm pursues KTT for the purpose of exploring new knowledge and which for the purpose of exploiting existing knowledge. The main motivation for this part study is that if there are discernible differences as to important firm characteristics between the firms that focus on exploration and those that concentrate on exploitation, this would be also relevant for the impact of KTT activities.

Model specification

Our questionnaire contains one question on the *specific nature* of the R&D projects that were realized in cooperation with universities or other research organizations, which allows us to operationalize the "exploration vs. exploitation" concept and to investigate whether there are differences with respect to the characteristics of firms pursuing the one or the other strategy:

Question 6.1:
"The knowledge exchange with universities has brought out:
(a) the initiation of new R&D projects: yes/no;
(b1) the development of new products: yes/no;
(b2) the development of new processes; yes/no".

Firms that reported that an outcome of their KTT activities was the initiation of new R&D projects are considered to pursue an "exploration" strategy aiming at an expansion of their knowledge base in the direction of new technologies. Firms that reported the development of new products and or new processes as the main goal of KTT activities are seen to pursue a

further "exploitation" strategy of an already existing knowledge base. Of course, there are also firms that reported both strategies.

As *dependent* variable served a nominal variable that takes the following four values referring to mutually exclusive groups of firms (variable EXPL).[10]

0: firms without KTT activities;

1: firms with KTT activities but without exploration or exploitation (reporting 'no' for both relevant questions; see footnote 3);

2: "exploration": firms responding *'yes' to question (a)* above and answering whatever to questions (b1) and (b2) ('exploration');

3: "exploitation": firms responding *'no' to question (a)* above and answering 'yes' to either question (b1) or (b2) or both of them ('exploitation').

The relevant characteristics of the firms that according to literature would be related to a firm's inclination to pursue the one or the other strategy are reflected in the choice of the independent variables. As *independent* variables we considered (a) variables that describe a firm's resource endowment as well as its knowledge absorptive capacity (Cohen and Levinthal 1990): human capital intensity (HQUAL); existence of a R&D department; R&D cooperation (R&D_COOP); and intensity of physical capital (LCL); (b) variables indicating the technological fields in which firms are active (dummy variables for 13 technological fields (see Table 6.1; model 1) or (alternatively) the technological diversification of firms, measured by the *number* of technological fields, in which a firm is active (TECH_DIV; model 2); (c) variables characterizing the market environment of firms (variable for the intensity of price competition (IPC), intensity of non-price competition (INPC) and the number of principal competitors in the main product marker (NCOMP)); and (d) a series of control variables such as firm size (LEMPL); firm age (FAGE); foreign-owned (FOREIGN) and sub-sectors dummy variables.

Expected are stronger positive effects for the exploration-oriented firms as compared with the exploitation-oriented firms for the variables reflecting absorptive capacity and for the technological diversification variable. Further, price competition is not expected to be relevant for exploration-oriented firms but rather non-price competition. Higher market concentration would be more favourable for exploration than for exploitation. As to firm size, firm age and the foreign affiliation we have no a priori expectations.

Given the character of the dependent variable multinomial probit estimation would be the appropriate econometric method to be applied.

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[10] The rather low number of observations did not allow the construction of a 'pure' category "exploration".

Since the results are only cross-section estimates, it is also in this case not possible to test directly the existence of causal relations between the independent variables, particularly KTT, and the dependent variables. Nevertheless, some robust regularities emerge, which, if interpreted in view of our main hypothesis, could indicate the direction of causal links.

6.2 Econometric results

Table 6.1 shows the multinomial probit estimates for the model that was outlined above. As reference group was used the exploitation-group, so that we can directly compare the relative importance of the various determining for the two relevant categories (exploration-firms versus exploitation firms). For reasons of brevity only the results for EXPL=2 (‘exploitation’) are presented in Table 6.1.

We obtain a clear pattern of the differences between ‘exploration’-oriented and ‘exploitation’-oriented firms. Firms with a focus on exploration show a significantly higher knowledge absorptive capacity (positive effects of the variables for human capital intensity, R&D cooperation and the existence of a R&D department) than firms that concentrate in exploitation. No difference could be found with respect to physical capital intensity. Exploration-oriented firms are not focussing to any particular type of technology (with the exception of *nanotechnology*) as compared with exploitation-oriented firms (model 1), but they show a significantly higher degree of technological diversification (in terms of the number of technological fields, in which they are active) than exploitation-oriented firms (model 2).

Larger and/or older firms appear to be stronger inclined to exploration than smaller and/or younger ones, but these effects are only partly statistically significant. As expected, price competition is more relevant for exploitation-oriented firms. No difference could be found with respect to non-price competition and the number of competitors (proxy for market concentration).

Finally, exploration-oriented and exploitation-oriented firms are found at the same extent in all sub-sectors of the economy.

In further investigations that are not presented here we analyzed also the impact of exploration-orientation and exploitation-orientation on the innovation and economic performance of the firms.

Table 6.1: Multinomial probit estimates; variable EXPL (0: no KTT activities; 1: KTT activities; neither 'exploration' nor 'exploitation'; 2: KTT activities; 'exploration'; 3: KTT activities; 'exploitation')

	Model 1 EXPL = 2	Model 2 EXPL = 2
LCL	0.063	0.068
	(0.063)	(0.062)
LQUAL	0.297**	0.281**
	(0.123)	(0.118)
R&D department	0.476**	0.413**
	(0.213)	(0.205)
R&D_COOP	0.561***	0.574***
	(0.197)	(0.190)
TECH_DIV		0.068*
		(0.039)
Technology:		
Nanotechnology	1.307***	
	(0.382)	
New materials	-0.250	
	(0.198)	
Microelectronics / semi-conductor technology	-0.205	
	(0.300)	
Laser technology/ optoelectronics / displays	-0.060	
	(0.307)	
Software / simulation / artificial intelligence	0.083	
	(0.200)	
Telecommunication / information technology	0.131	
	(0.232)	
Biotechnology / gene technology	0.201	
	(0.492)	
Medical technology / sanitary engineering	0.146	
	(0.265)	
Computer-integrated manufacturing technology	0.252	
	(0.220)	
Transport technology / traffic engineering / logistics	0.169	
	(0.229)	
Energy technologies	-0.124	
	(0.241)	
Environmental technologies	-0.010	
	(0.215)	
Geological technologies	-0.120	
	(0.570)	
LEMPL	0.095	0.102*
	(0.062)	(0.060)
LAGE	0.192*	0.150
	(0.116)	(0.112)
FOREIGN	-0.202	-0.116
	(0.228)	(0.220)

IPC	-0.176**	-0.172**
	(0.089)	(0.086)
INPC	0.121	0.112
	(0.098)	(0.094)
NCOMP	-0.096	-0.093
	(0.068)	(0.066)
HT	-0.355	-0.246
	(0.438)	(0.417)
LT	-0.518	-0.424
	(0.427)	(0.414)
MDL	-0.469	-0.329
	(0.445)	(0.424)
TDL	-0.238	-0.155
	(0.475)	(0.457)
N	1728	455
Waldchi2	479.5	104.1
Prob > chi2	0.000	0.000

Note: Reference group: EXPL = 3 ('exploitation'); see Table 1 for the definition of EXPL. ***, ** and * denote statistical significance at the 1%-, 5%- and 10%-test level respectively.

7. KTT activities in the Swiss economy: The main facts from the point of view of *science institutions*

7.1 Incidence of KTT activities

A slightly larger proportion of institutes reported (reference period: 2008-2010) KTT activities in 2011 than in 2005 (reference period: 2002-2004): 88% versus 84% (Table 7.1). The positive change was largest in the ETH Domain, while in the other two groups of science institutions this proportion remained almost constant.[11]

Table 7.1: Incidence of KTT activities according to group of science institutions; percentage of all firms

	2002-2004	2002-2004 Foreign partners	2008-2010	2008-2010 Foreign partners
ETH Domain	80.9	72.1	92.3	78.9
Cantonal Universities	79.9	72.8	78.6	64.3
Universities of Applied Sciences	96.6	64.4	100.0	90.5
Total	*83.8*	*70.5*	*88.4*	*75.6*

7.2 Forms of KTT activities

Concerning the forms of KTT activities, the pattern of the main groups of KTT activities also remained relatively stable over time (Tables 7.2a and 7.2b). However, there was a distinct decrease in the proportion of institutes reporting *informational* activities (2011: 69%; 2005: 79%). This effect can be traced back to the ETH Domain (minus 14 percentage points) as well as the Cantonal Universities (minus 10 percentage points). A slight increase was reported for consulting activities.

[11] For a detailed analysis of the 2005 results see Arvanitis et al. 2008a.

Table 7.2a: Main categories of forms of KTT activities according to groups of science institutions; percentage of firms reporting 4 or 5 on a five-point Likert scale for any single form of a certain main form of KTT activities

2011	Information	Infrastructure	Education	Research	Consulting
ETH Domain	60.4	18.8	75.0	77.1	43.8
Cantonal Universities	69.1	20.0	78.2	63.6	43.6
Universities of Applied Sciences	78.6	7.1	97.6	92.9	78.6
Total	*69.0*	*15.9*	*82.8*	*76.6*	*53.8*

Table 7.2b: Main categories of forms of KTT activities according to groups of science institutions; percentage of firms reporting 4 or 5 on a five-point Likert scale for any single form of a certain main form of KTT activities

2005	Information	Infrastructure	Education	Research	Consulting
ETH Domain	74.5	12.7	80.0	78.2	43.6
Cantonal Universities	78.9	22.5	71.1	66.7	47.8
Universities of Applied Sciences	82.5	14.0	94.7	86.0	56.1
Total	*78.7*	*17.4*	*80.2*	*75.2*	*49.0*

7.3 Mediating institutions of KTT activities

Some interesting changes can be noted since the earlier period that reflect the increase in relevance and presumably also in the effectiveness of the mediating services of CTI and the University Transfer Offices (Tables 7.3a and 7.3b) much more clearly than the firm view (Table 3.10). The better position of the transfer offices can be traced back primarily to the positive changes in the Cantonal Universities. The CTI increase reflected a stronger involvement in CTI projects in all three groups of science institutions. The same can also be said of the Framework Programmes of the European Union. The importance of such programmes nearly tripled. As to the SNSF, a stronger involvement was found for the ETH Domain and for the Universities of Applied Sciences.

Table 7.3a: Importance of single mediating institutions according to group of science institutions; percentage of institutes reporting 4 or 5 on a five-point Likert scale

2011	Transfer offices	Innovation Promotion Agency (CTI)	Swiss National Science Foundation (SNSF)	Framework Programmes EU	Other Research Programmes EU
ETH Domain	29.2	52.1	27.1	47.9	20.8
Cantonal Universities	33.3	31.6	22.8	26.3	17.5
Universities of Applied Sciences	19.1	57.1	9.5	28.6	11.9
Total	*27.9*	*45.6*	*20.4*	*34.0*	*17.0*

Table 7.3b: Importance of single mediating institutions according to group of science institutions; percentage of institutes reporting 4 or 5 on a five-point Likert scale

2005	Transfer offices	Innovation Promotion Agency (CTI)	Swiss National Science Foundation (SNSF)	Framework Programmes EU	Other Research Programmes EU
ETH Domain	22.4	39.7	13.8	13.8	36.2
Cantonal Universities	16.0	17.0	31.9	14.9	16.0
Universities of Applied Sciences	12.3	33.3	5.3	8.8	12.3
Total	*16.8*	*27.8*	*19.6*	*12.9*	*20.6*

7.4 Obstacles to KTT activities

The relevance of two groups of obstacles has *decreased significantly* since 2002-2004, i.e. "lack of information" and "costs, risks, uncertainty" (Tables 7.4a and 7.4b). In the 2008-2010 period, three further categories of problems were perceived as serious obstacles to KTT activities to about the same extent as in the 2002-2004 period, i.e. "firm deficiencies" and "deficiencies of science institutions" and "organisational or institutional obstacles". An increase was found only for the obstacle "problems in teaching and research" (caused by involvement in KTT). *On the whole, the obstacles seem to be less severe than in the former period.*

The "problems in teaching and research" are relevant primarily in the Universities of Applied Sciences. The decrease in the category "costs, risks and uncertainty" comes primarily from the ETH Domain.

Table 7.4a: Main categories of obstacles according to group of science institutions; percentage of institutes reporting 4 or 5 on a five-point Likert scale for any single obstacle in a certain category of obstacles

2011	Lack of information	Problems in teaching / research	Firm deficiencies	Deficiencies of the science institutions	Costs, risks, uncertainty	Organisational/ institutional obstacles
ETH Domain	13.5	23.1	19.2	17.3	19.2	3.9
Cantonal Universities	20.6	29.9	18.6	20.0	16.2	13.2
Universities of Applied Sciences	21.4	28.6	19.1	14.3	42.9	14.3
Total	*18.5*	*27.0*	*18.9*	*17.7*	*24.1*	*10.5*

Table 7.4b: Main categories of obstacles according to group of science institutions; percentage of institutes reporting 4 or 5 on a five-point Likert scale for any single obstacle in a certain category of obstacles

2005	Lack of information	Problems in teaching / research	Firm deficiencies	Deficiencies of the science institutions	Costs, risks, uncertainty	Organisational/ institutional obstacles
ETH Domain	24.6	21.7	27.0	17.5	41.3	12.7
Cantonal Universities	28.8	24.3	15.5	21.6	20.9	10.0
Universities of Applied Sciences	31.0	13.0	13.8	15.5	43.1	10.3
Total	*28.3*	*20.9*	*18.2*	*19.0*	*32.0*	*10.8*

8. Summary and conclusions

8.1 Results of the firm survey

The firm survey was conducted on the autumn 2011; 1841 valid answers were receive, which corresponds to a response rate of 40%.

Incidence of KTT activities

About 21% of all firms in the sample were involved in KTT activities with universities and other research institutions between 2008 and 2010. In the period of 2002-2004 the respective figure was 22%. Thus, the share of firms with KTT activities has remained approximately constant in the past six years. There is a significant increase in the share of KTT-active firms in high-tech manufacturing and in knowledge-based services, but also a discernible decrease in the respective share in low-tech manufacturing as well as in ”traditional” services. Every second large firm in Switzerland (i.e. with 250 and more employees) is involved in KTT activities.

Main forms of KTT activities

The KTT-active firms were asked to assess the importance of 19 different single forms of KTT activities that were classified in five categories: *informal contacts* with a primarily general informational character, *educational activities*, activities related to *technical infrastructure*, *research activities* and *consulting*.

There is a slight increase in informational and educational activities as compared to the period of 2002-2004. The proportion of firms engaged in research and consulting activities has remained approximately constant in the past six years.

Science institutions as partners of KTT activities

The percentage of all three types of science institutions has increased since 2002-2004, but the increase for the ETH Domain and for the Universities of Applied Sciences was discernibly larger than that of the Cantonal Universities.

The business partners of the institutions of the ETH Domain and the Universities of Applied Sciences are evenly distributed among the three sectors of manufacturing, construction and services. The Cantonal Universities have a considerably higher proportion of partners in the service sector than in manufacturing and construction. The institutions of the ETH Domain cooperate to a greater extent with high-tech firms and firms from the more knowledge-intensive service industries than the other two groups of science institutions.

Mediating institutions

From the point of view of firms, the relevance of all five types of KTT-mediating institutions (CTI, Transfer Offices, SNSF, EU Framework Programmes, and other EU Research Programmes) has increased since 2002-2004, but it is still only a small number of KTT-active

firms that seem to be aware of the mediating services of these institutions. However, the Innovation Promotion Agency (CTI) is the most important institution, especially for medium-sized high-tech manufacturing firms. Transfer offices are next in importance, particularly for small firms and/or firms in modern services emphasised their usefulness.

Motives for KTT activities

"Access to human capital" is by far the most important motive for technology transfer with universities, followed by "financial motives", "access to research results", and "institutional motives". There are no discernible differences between the two periods.

Obstacles of KTT activities

All the firms were asked to assess the importance of 26 different possible single obstacles to KTT activities. They were pooled into five main groups of obstacles, i.e. "lack of information", "firm deficiencies", "university deficiencies", "costs, risks, uncertainty", and "institutional/organisational obstacles".

For all firms the obstacle categories "firm deficiencies", "costs, risks, uncertainty" and "deficiencies of science institutions" are still the most important categories of obstacles. This was also the case in the earlier survey 2005. Only small differences can be detected over time. "Firm's research questions not being interesting for science institutions" and "lack of interest for scientific projects" are the most frequently reported single obstacles in the category "firm deficiencies" Both of them show about the same percentages of reporting firms as in the 2002-2004 period.

The obstacle profile described above reflects to a large extent also the obstacle profile of KTT-inactive firms. However, there are differences compared to KTT-active firms. KTT-active firms are predominantly prevented from intensifying their KTT activities through "cost, risks, uncertainty"-related obstacle categories, followed by "firm deficiencies" and "deficiencies of science institutions".

A more in-depth econometric analysis of the impact of obstacles on the propensity to KTT activities shows that 9 out of 26 single obstacles appear to hamper effectively KTT activities. The most severe obstacles come from firms themselves ('firm deficiencies'). *Policy-relevant* are primarily those impediments that can be influenced by the behaviour of science institutions, namely those related with *deficiencies of science institutions* (in particular the obstacles 'lack of scientific staff for transfer activities' and 'possible results cannot be commercialized').

Drivers of KTT activities

Human capital intensity and the propensity to R&D activities show the largest positive effects on the overall propensity to KTT activities. Both variables are closely related to a firm's ability to absorb new knowledge from its environment. Also capital intensity is also relevant

for distinguishing between firms with KTT activities and those without this type of activities. Export intensity taken as a measure of a firm's degree of exposition to international competition shows also a significantly positive effect, which is much smaller than that for human capital, R&D intensity and capital intensity. The variable for firm age has a significantly positive coefficient, thus indicating that older firms are stronger inclined to get involved in KTT activities than younger ones, presumably because they have a greater experience in co-operating with science institutions than younger ones. There is a significant difference between domestic and foreign firms with respect to KTT activities: foreign-owned firms seem to be less inclined to cooperation with domestic science institutions than domestic-owned firms. Finally, larger firms appear to be stronger inclined to KTT activities than smaller firms. Firms with KTT activities seem to have a focus on biotechnology/gene technology, nanotechnology, new materials, software/simulation/artificial intelligence and environmental technologies (in decreasing ranking order as to the magnitude of the effects).

Impact of KTT activities

(a) What the firms report:

Although "access to human capital" provides the greatest motivation for transfer activities, the greatest impact refers to the "development of new processes" and "development of new products", i.e., "knowledge exploitation" outcomes, followed by "recruitment" and "further education". New processes are predominantly developed by large firms in the modern service sector, while new products are most frequently the result of transfer activities for large high-tech manufacturing firms. "Initiation of new innovation projects" ("knowledge exploration" outcomes) is seen to be considerably less frequent than "knowledge exploitation" outcomes.

(b) Econometric results:

We found a positive and statistically highly significant effect of the variable KTT on the sales share of innovative products. This is an important result emphasizing the relevance of KTT activities for a firm's innovation performance.

KTT activities do not seem to impact directly productivity. There is a positive indirect effect through innovation performance that exercises itself a positive influence on labour productivity.

Exploration versus exploitation

We obtain a clear pattern of the differences between "exploration"-oriented and "exploitation"-oriented firms. Firms with a focus on exploration show a significantly higher knowledge absorptive capacity (positive effects of the variables for human capital intensity, R&D cooperation and the existence of an R&D department) than firms that concentrate in exploitation. No difference could be found with respect to physical capital intensity. Exploration-oriented firms are not focussing to any particular type of technology (with the

exception of *nanotechnology*) as compared with exploitation-oriented firms, but they show a significantly higher degree of technological diversification (in terms of the number of technological fields, in which they are active) than exploitation-oriented firms. Larger and/or older firms appear to be stronger inclined to exploration than smaller and/or younger ones, but these effects are only partly statistically significant. Price competition is more relevant for exploitation-oriented firms. No difference could be found with respect to non-price competition and the number of competitors. Finally, exploration-oriented and exploitation-oriented firms are found at the same extent in all sub-sectors of the economy.

8.2 Results of the institutes survey

Incidence of KTT activities

A slightly larger proportion of institutes reported (reference period: 2008-2010) KTT activities in 2011 than in 2005 (reference period: 2002-2004): 88% versus 84%. The positive change was largest in the ETH Domain, while in the other two groups of science institutions this proportion remained almost constant.

Forms of KTT activities

Concerning the forms of KTT activities, the pattern of the main groups of KTT activities also remained relatively stable over time. However, there was a distinct decrease in the proportion of institutes reporting informational activities. A slight increase was reported for consulting activities.

Mediating institutions

Some interesting changes can be noted since the earlier period that reflect the increase in relevance and presumably also in the effectiveness of the mediating services of CTI and the University Transfer Offices much more clearly than the firm view. The better position of the transfer offices can be traced back primarily to the positive changes in the Cantonal Universities. The CTI increase reflected a stronger involvement in CTI projects in all three groups of science institutions. The same can also be said of the Framework Programmes of the European Union. The importance of such programmes nearly tripled. As to the SNSF, a stronger involvement was found for the ETH Domain and for the Universities of Applied Sciences.

Obstacles of KTT activities

The relevance of two groups of obstacles has *decreased significantly* since 2002-2004, namely “lack of information” and “costs, risks, uncertainty”. In the 2008-2010 period, three further categories of problems were perceived as serious obstacles to KTT activities to about the same extent as in the 2002-2004 period, i.e. “firm deficiencies” and “deficiencies of science institutions” and “organisational or institutional obstacles”. An increase was found

only for the obstacle “problems in teaching and research” (caused by involvement in KTT). On the whole, the obstacles seem to be less severe than in the former period.

8.3 Policy-relevant aspects

Directly policy-relevant are the results referring to the relative importance and effective influence of “deficiencies of science institutions” as seen from the firms. This category of obstacles is also in the period 2008-2010 the second most frequently reported category (about 40% of all firms). Especially the two most relevant single obstacles of this category (“R&D orientation of science institutions is uninteresting for firms” and “Possible R&D results cannot be commercialized”) indicate possible weaknesses from the part of the science institutions on the interface between science and business.

The discernibly higher firms’ awareness of the mediating services of institutions such as the CTI and the Transfer Offices in the period 2008-2010 is presumably the result of additional efforts of these institutions to reach firms and inform them about their services.

Indirectly policy-relevant are the results with respect to exploration/exploitation. The clear pattern of the differences between ‘exploration’-oriented and ‘exploitation’-oriented firms we obtained in our econometric estimations shows firms with a focus on exploration have a significantly higher knowledge absorptive capacity. This means that exploration-oriented firms would be able to utilize in the long-run more effectively university knowledge than firms that focus on (rather short-term) benefits from the completion of current R&D projects. For science institutions this means that two groups of KTT-partners can be distinguished with different “knowledge requirements”, thus different consequences with respect to the utilization of acquired knowledge.

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APPENDIX

Table A.1: Composition of dataset of *firms* by industry

	2005		2011	
Industry	N	Percentage	N	Percentage
Food/beverage	127	4.9	86	4.8
Textiles	30	1.2	19	1.0
Clothing/leather	11	0.4	4	0.2
Wood processing	56	2.2	32	1.7
Paper	31	1.2	22	1.2
Printing	91	3.5	60	3.3
Chemicals	93	3.6	85	4.6
Plastics/rubber	58	2.2	50	2.7
Glass/stone/clay	47	1.8	29	1.6
Metal	39	1.5	25	1.4
Metal-working	173	6.7	147	8.0
Machinery	269	10.4	161	8.7
Electrical machinery	87	3.4	55	3.0
Electronic/instruments	152	5.9	114	6.2
Watches	54	2.1	40	2.2
Vehicles	29	1.1	15	0.8
Other manufacturing	54	2.1	32	1.7
Energy/water	49	1.9	37	2.0
Construction	271	10.5	200	10.8
Wholesale	215	8.3	169	9.1
Transport	154	6.0	141	7.7
Banking/insurance	179	6.9	120	6.5
Computer services	79	3.1	38	2.1
Business services	216	8.4	152	8.3
Telecommunication	18	0.7	8	0.4
Total	*2582*	*100*	*1841*	*100*

Table A.2: Composition of the dataset of *institutes* by group of science institutions

	2005		2011	
	N	Percentage	N	Percentage
ETH Domain	68	28.2	52	31.7
Cantonal Universities	114	47.3	70	42.7
Universities of Applied Sciences	59	24.5	42	25.6
Total	*241*	*100.0*	*164*	*100.0*

Table A.3: Response rates in % by industry

Industry	%
Food/beverage	44.4
Textiles	36.5
Clothing/leather	21.1
Wood processing	36.4
Paper	41.5
Printing	40.8
Chemicals	40.7
Plastics/rubber	52.1
Glass/stone/clay	31.9
Metal	38.5
Metal-working	42.6
Machinery	37.8
Electrical machinery	39.0
Electronic/instruments	40.7
Watches	34.5
Vehicles	27.8
Other manufacturing	35.2
Energy/water	46.3
Construction	37.1
Wholesale	38.9
Transport	44.9
Banking/insurance	42.7
Computer services	35.5
Business services	43.6
Telecommunication	26.7
Total (N=1842)	*40.0*

Questionnaires

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KOF

Befragung 2011
Wissensaustausch wissenschaftliche Institutionen und Unternehmungen in der Schweiz

Unternehmungen

- Alle Angaben werden **streng vertraulich** behandelt
- Die Antworten, wenn nicht anders verlangt, beziehen sich auf den **Standort Schweiz**.
- Bei Unklarheiten bitte die Erläuterungen beachten.
- Zutreffendes Feld ☒ bitte ankreuzen oder Wert eintragen
- Der Fragebogen ist für die Rückantwort auf der letzten Seite adressiert.

Bitte senden Sie uns den Fragebogen bis spätestens

25. März 2011

zurück, auch wenn nicht alle Fragen vollständig beantwortet werden können.

1. Angaben zur Unternehmung

1.1 Ist Ihre Unternehmung mehrheitlich in **ausländischem Besitz**?

ja ☐ (7) nein ☐

Falls ja, bitte Land angeben: _____

1.2 **Gründungsjahr** der Unternehmung (ohne Berücksichtigung von rein juristischen Statusveränderungen)

☐☐☐☐ (34)

1.3 Anzahl der **Beschäftigten** in der Schweiz Ende 2010 (inkl. mitarbeitende Inhaber, Lehrlinge, Aushilfen, usw.; Teilzeitstellen auf Vollzeitstellen umrechnen)

☐☐☐☐☐ (38)

1.4 Der Anteil folgender **Personalkategorien** an der Gesamtbeschäftigung betrug Ende 2010 schätzungsweise: (Teilbeschäftigte auf Vollzeitstellen umrechnen)

- Akademiker	☐☐☐ % (45)
- Personen mit einem Abschluss höher als Berufslehre	☐☐☐ %
- Gelernte (Berufslehre)	☐☐☐ %
- An- und Ungelernte	☐☐☐ %
- Lehrlinge	☐☐☐ % (57)
Total Beschäftigte	1 0 0 %

1.5 **Umsatz** (ohne MWST) der Unternehmung ab **Standort Schweiz** 2010:

CHF ☐☐ ☐☐☐ ☐☐☐ ☐☐☐ (68)

Banken: Erträge aus Zins-, Handels- und Kommissionsgeschäft sowie Dienstleistungsgeschäft;
Versicherungen: Bruttoprämien - Bruttozahlungen für Versicherungsfälle + Nettoertrag aus Kapitalanlagen;
Beratungsfirmen u.ä.: Bruttohonorarertrag

1.6 a) Exportiert Ihre Unternehmung Gürter/Dienstleistungen?

ja ☐ (69) nein ☐

Dienstleistungsexporte beinhalten auch die Dienstleistungen für ausländische Kunden, die in der Schweiz bezogen werden, wie z.B. Hotelaufenthalte ausländischer Touristen.

b) **Falls ja:**
Anteil der **Exporte** am Umsatz 2010: ☐☐☐ % (70)

1.7 Anteil des **Personalaufwandes** am Umsatz 2010: ☐☐☐ % (73)

1.8 Gesamtwert der **Einkäufe von Waren und Dienstleistungen** (ohne MwSt) als Anteil am Umsatz 2010: ☐☐☐ % (76)

Ausgaben für **Waren** (Materialien, Vor-/Zwischenprodukte, usw.) und **Dienstleistungen** von Banken, Versicherungen, Telekom etc., **nicht aber Ausgaben für Investitionsgüter**.

1.9 **Bruttoinvestitionen 2010** (ohne MwSt) am Standort Schweiz: (notfalls Schätzwert angeben)

CHF ☐☐ ☐☐☐ ☐☐☐ ☐☐☐ (89)

Investitionen in eigengenutzten Betriebsbauten (neuerstellten Betriebsbauten, Umbauten, Renovationen etc.), Ausrüstungsinvestitionen (Fahrzeuge, Maschinen, Geräte, Büroausrüstung etc.) und Softwareinvestitionen

1.10 Beurteilung der **Wettbewerbsintensität** auf dem **Hauptabsatzmarkt** hinsichtlich:

	sehr schwach 1	2	3	4	sehr stark 5	
- Preis	☐	☐	☐	☐	☐	90
- Nichtpreisliche Wettbewerbsdimensionen	☐	☐	☐	☐	☐	91

Beispiele für **nichtpreisliche Wettbewerbsdimensionen** sind Produktdifferenzierung, häufige Einführung neuer Produkte, technischer Vorsprung, Flexibilität bei Kundenwünschen oder Serviceleistungen.

1.11 Anzahl in- und ausländischer **Hauptkonkurrenten** auf dem **Hauptabsatzmarkt**:

- bis 5 ☐
- 6 bis 10 ☐
- 11 bis 15 ☐
- 16 bis 50 ☐
- mehr als 50 ☐ 92

1.12 Unsere Unternehmung hat in folgenden **technologischen Bereichen** in der Periode 2008-2010 **Aktivitäten** entwickelt (Mehrfachnennungen möglich):

	ja	nein	
- Nanotechnologie	☐	☐	93
- Neue Werkstoffe, neue Materialien	☐	☐	
- Mikroelektronik und Halbleitertechnik	☐	☐	
- Lasertechnik, Optoelektronik, Displays	☐	☐	
- Informatik: Software, Simulation, Künstliche Intelligenz	☐	☐	
- Telekommunikations- und Informationstechnik	☐	☐	
- Bio- / Gentechnologie	☐	☐	
- Medizinal- und Gesundheitstechnik	☐	☐	
- Flexible integrierte Fertigungstechnik	☐	☐	
- Transport-, Verkehrstechnik, Logistik	☐	☐	
- Energietechnologien	☐	☐	
- Umwelttechnik und ressourcenschonende Techniken	☐	☐	
- Geowissenschaftliche Techniken	☐	☐	
- Mathematische Finanzmodelle	☐	☐	106
- Andere, nämlich: _____			

2. Innovationsaktivitäten / Forschungs- und Entwicklungsaktivitäten (F&E)

Produkte können Güter oder Dienstleistungen sein.

1) **Produktinnovationen** sind technisch neue oder erheblich verbesserte Produkte aus der Sicht Ihrer Unternehmung, d.h. Produkte, die hinsichtlich ihres Einsatzes, ihrer Qualität oder wegen der zu ihrer Erstellung verwendeten physischen oder interaktiven Elemente neu sind oder in ihrer Leistungsart grundlegend verbessert bzw. verändert wurden. Keine Produktinnovationen sind rein ästhetische Modifikationen von Produkten (z.B. Farbgebung, Styling) und Produktvariationen, z.B. aufgrund von Kundenspezifikationen, bei denen das Produkt (Gut oder Dienstleistung) hinsichtlich seiner technischen Grundzüge und Verwendungseigenschaften weitgehend unverändert bleibt.

(Handel: Produktinnovationen sind Neuerungen bei der Distribution, nicht aber Innovationen bei den gehandelten Gütern).

2) **Prozessinnovationen** beziehen sich auf den für Ihre Unternehmung erstmaligen Einsatz technisch neuer oder erheblich verbesserter Fertigungs-/Verfahrenstechniken zur Herstellung der Güter bzw. zur Erbringung der Dienstleistungen an Personen oder Objekten. Zwar kann sich dabei auch das Produkt verändern, doch steht die Steigerung der Effizienz im Vordergrund. Von Ihnen neu entwickelte Produktionsverfahren, die an andere Unternehmen verkauft werden, werden hier als Produktinnovationen angesehen. Rein organisatorische oder Management-Veränderungen werden nicht zu den Prozessinnovationen gezählt.

2.1 a) Haben Sie in den drei Jahren 2008-2010 **Innovationen** eingeführt?

JA:
- Produktinnovationen[1] ☐ 158
- Prozessinnovationen[2] ☐ 159

NEIN:
- Weder Produkt- noch Prozessinnovationen eingeführt ☐ 160

b) **Falls ja**:
Haben Sie die eingeführten Innovationen vollständig oder teilweise in Kooperation mit wissenschaftlichen Institutionen entwickelt?

ja 161 ☐ nein ☐

Unter **wissenschaftlichen Institutionen** verstehen wir die beiden ETH in Zürich und Lausanne, die vier Eidgenössischen Forschungsanstalten PSI, EAWAG, EMPA und WSL sowie die kantonalen Universitäten und die Fachhochschulen, wobei eine detaillierte Auflistung der wissenschaftlichen Institutionen in der **Frage 4.1** erfolgt.

2.2 Der **Umsatz** Ihrer Unternehmung verteilte sich 2010 auf folgende **Produkttypen**:

	Umsatzanteil	
- Seit Anfang 2008 **neu** eingeführte Produkte	☐☐☐	%
- Seit Anfang 2008 **erheblich verbesserte** Produkte	☐☐☐	%
- Seit Anfang 2008 nicht oder nur **unerheblich veränderte** Produkte	☐☐☐	% 170
Gesamtumsatz	100	%

2.3 **F&E-Aktivitäten**: Hat Ihre Unternehmung in den drei Jahren 2008-2010 F&E durchgeführt?

ja (171) ☐ nein ☐

→ **Falls nein, dann weiter zu Frage 2.8**

2.4 **Wie häufig** führen Sie F&E-Aktivitäten durch?

- gelegentlich ☐
- kontinuierlich ☐ (172)

2.5 Unsere Unternehmung hat eine oder mehrere **F&E-Abteilungen** in der Schweiz:

ja (173) ☐ nein ☐

2.6 **Kumuliert** über die drei Jahre 2008-2010 betrugen unsere **F&E-Ausgaben** am **Standort Schweiz** schätzungsweise:

CHF ☐☐ ☐☐☐ ☐☐☐ ☐☐☐ (184)

davon: Anteil für F&E-Aufträge an Dritte: ☐☐☐ % (187)

2.7 **Kooperation im F&E-Bereich mit anderen Unternehmungen**
Hat Ihre Unternehmung bei den F&E-Aktivitäten (ohne externe F&E-Aufträge) in der Periode 2008-2010 mit anderen Unternehmungen kooperiert? (z.B. F&E-Vereinbarung, Joint Venture, Vereinbarung zum Technologieaustausch)

ja (188) ☐ nein ☐

2.8 Wir haben in den drei Jahren 2008-2010 **Patente** angemeldet: (pro Erfindung nur eine Patentmeldung ohne Berücksichtigung von Mehrfachanmeldungen derselben Erfindung z.B. in verschiedenen Ländern)

ja (189) ☐ nein ☐

Falls ja, wieviele? ca.: ☐☐☐☐ (193)

3. Formen und Medien des Wissensaustauschs mit wissenschaftlichen Institutionen

3.1 Gab es in Ihrer Unternehmung Aktivitäten, die auf den **Wissensaustausch** mit wissenschaftlichen Institutionen in der Schweiz (kurz: Hochschulen) abzielten?

	ja	nein
a) 2005-2007	☐	☐ (194)
b) 2008-2010	☐	☐ (195)

c) Gab es in den drei Jahren 2008-2010 Wissensaustausch-aktivitäten mit **ausländischen** wissenschaftlichen Institutionen?

ja ☐ nein ☐ (196)

Falls ja:

(197) ☐ EU ☐ USA

(199) ☐ Japan ☐ sonstiges Ausland: _____

Mit **Wissensaustausch** zwischen **wissenschaftlichen Institutionen** (kurz: Hochschulen) und Unternehmungen bezeichnen wir alle Aktivitäten, die darauf abzielen, Wissen zu übertragen, welches - je nach Richtung des Austausches - der beteiligten Unternehmung bzw. der beteiligten Hochschule für ihre Tätigkeit nützlich sein kann.

Der Wissensaustausch deckt eine breite Palette von Aktivitäten ab, die in **Frage 3.2** aufgelistet sind und sich auf die wissenschaftlichen Institutionen beziehen, die in **Frage 4.1** erwähnt sind.

! → **Falls nein bei a) und b) weiter zu Frage 7 (Hemmnisse)**

3.2 Welche **Formen** nimmt der Wissensaustausch Ihrer Unternehmung mit Hochschulen an und wie bedeutend sind diese Formen für Ihre Unternehmung? (Mehrfachantworten möglich)

	keine Bedeutung 1	2	3	4	sehr grosse Bedeutung 5
Informelle Kontakte, persönliches Netzwerk					
- Informelle Kontakte (z.B. per Telefon, E-mail) mit Hochschul-Angehörigen zum Informationsaustausch	☐	☐	☐	☐	☐ (226)
- Besuch von Konferenzen, Ausstellungen, Workshops etc. der Hochschulen	☐	☐	☐	☐	☐
- Lesen bzw. zitieren wissenschaftlicher Publikationen der Hochschulen	☐	☐	☐	☐	☐
Technische Infrastruktur					
- Gemeinsame Labors	☐	☐	☐	☐	☐ (229)
- Nutzung technischer Infrastruktur von Hochschulen bzw. öffentlichen Forschungszentren	☐	☐	☐	☐	☐
Ausbildung, Weiterbildung, Personalmobilität					
- Anstellung von Hochschulabsolventen im F&E-Bereich	☐	☐	☐	☐	☐
- Kontakt eingestellter Hochschulabsolventen mit ihrem Labor an der Hochschule	☐	☐	☐	☐	☐
- Teilnahme von Studenten/ Praktikanten an F&E-Projekten unserer Unternehmung	☐	☐	☐	☐	☐ (233)

	keine Bedeutung 1	2	3	4	sehr grosse Bedeutung 5	
- Vergabe von Diplomarbeiten in Kooperation mit Hochschulen	☐	☐	☐	☐	☐	234
- Vergabe von Dissertationen in Kooperation mit Hochschulen	☐	☐	☐	☐	☐	
- Mitarbeit von Wissenschaftlern der Hochschulen an F&E-Projekten unserer Unternehmung (inkl. "industrial sabbaticals")	☐	☐	☐	☐	☐	
- Gemeinsame Lehrveranstaltungen	☐	☐	☐	☐	☐	
- Lehrauftrag von Mitarbeitern unserer Unternehmung an Hochschulen	☐	☐	☐	☐	☐	
- Besuch fachspezifischer Weiterbildungskurse (Ausbildungsprogramme) an Hochschulen von Mitarbeitern	☐	☐	☐	☐	☐	
Forschung						
- Forschungsprojekte in Kooperation mit Hochschulen (teilweise oder vollständig finanziert durch unsere Unternehmung)	☐	☐	☐	☐	☐	240
- Längerfristige Forschungsverträge mit Hochschulen (Auftragsforschung)	☐	☐	☐	☐	☐	
- Forschungskonsortien (mit mindestens einer Hochschulbeteiligung)	☐	☐	☐	☐	☐	
Beratung						
- Gutachten von Seiten der Hochschulen	☐	☐	☐	☐	☐	243
- Beratungsleistung von Seiten der Hochschulen	☐	☐	☐	☐	☐	

3.3 Wie wichtig sind folgende Institutionen als **Vermittler** für das Anknüpfen von formalen Kontakten mit Hochschulen?

	keine Bedeutung 1	2	3	4	sehr grosse Bedeutung 5	
- Technologietransferstelle der Hochschulen	☐	☐	☐	☐	☐	245
- Kommission für Technologie und Innovation (KTI)	☐	☐	☐	☐	☐	
- Schweizerischer Nationalfonds (SNF)	☐	☐	☐	☐	☐	
- Rahmenprogramme der Europäischen Union (EU)	☐	☐	☐	☐	☐	
- Sonstige Forschungsprogramme der EU	☐	☐	☐	☐	☐	249
- Andere Institutionen, nämlich _____						

4. Partner des Wissensaustauschs

4.1 Mit welchen Schweizer **wissenschaftlichen Institutionen** (bzw. Hochschulen) und in welcher **Form** (informelle Kontakte, Ausbildung, Forschung, techn. Infrastruktur, Beratung) hat Ihre Unternehmung in den drei Jahren 2008-2010 **Wissensaustausch** betrieben? (Mehrfachnennungen möglich)

	Informelle Kontakte, Persönliches Netzwerk	Ausbildung, Weiterbildung Personalmobilität	Beratung	Techn. Infrastruktur	Forschung	Anzahl Forschungsprojekte
Institutionen des ETH-Bereichs:						
- Eidg. Technische Hochschule Zürich (ETHZ)	☐ 300	☐	☐	☐	☐	☐☐
- Ecole Polytechnique Fédérale de Lausanne (EPFL)	☐	☐	☐	☐	☐	☐☐
- Paul Scherrer Institut (PSI)	☐	☐	☐	☐	☐	☐☐
- Eidg. Anstalt für Wasserversorgung, Abwasserreinigung und Gewässerschutz (EAWAG)	☐	☐	☐	☐	☐	☐☐
- Eidg. Materialprüfungs- und Forschungsanstalt (EMPA)	☐	☐	☐	☐	☐	☐☐
- Eidg. Forschungsanstalt für Wald, Schnee und Landschaft (WSL)	☐ 335	☐	☐	☐	☐	☐☐
Universitäten:						
- Universität Bern	☐ 342	☐	☐	☐	☐	☐☐
- Universität Basel	☐	☐	☐	☐	☐	☐☐
- Université de Fribourg	☐	☐	☐	☐	☐	☐☐
- Université de Genève	☐	☐	☐	☐	☐	☐☐
- Université de Lausanne	☐ 370	☐	☐	☐	☐	☐☐
- Université de Neuchâtel	☐	☐	☐	☐	☐	☐☐
- Universität St. Gallen	☐	☐	☐	☐	☐	☐☐
- Università della Svizzera Italiana	☐	☐	☐	☐	☐	☐☐
- Universität Zürich	☐ 398	☐	☐	☐	☐	☐☐
Fachhochschulen:						
- Berner Fachhochschule (BFH)	☐ 405	☐	☐	☐	☐	☐☐
- Fachhochschule Nordwestschweiz (FHNW)	☐	☐	☐	☐	☐	☐☐
- Fachhochschule Ostschweiz (FHO)	☐	☐	☐	☐	☐	☐☐
- Fachhochschule Zentralschweiz (FHZ)	☐	☐	☐	☐	☐	☐☐
- Haute école spécialisée de Suisse occidentale (HES-SO):	☐	☐	☐	☐	☐	☐☐
- Scuola universitaria professionale della Svizzera Italiana (SUPSI)	☐	☐	☐	☐	☐	☐☐
- Zürcher Fachhochschule (ZFH)	☐ 447	☐	☐	☐	☐	☐☐

5. Motive und Ziele für den Wissensaustausch mit wissenschaftlichen Institutionen

5.1 Was sind Ihre **Motive** und **Ziele** für Wissensaustauschbeziehungen mit wissenschaftlichen Institutionen (kurz: Hochschulen) und welche Bedeutung haben sie?
(Mehrfachantworten möglich)

Zugang zu Humankapital, personengebundenem Wissen ("tacit knowledge")

	keine Bedeutung 1	2	3	4	sehr grosse Bedeutung 5	
- Zugang zu spezifischen Fähigkeiten als Ergänzung von unternehmensinternem Know-how	☐	☐	☐	☐	☐	454
- Neue Forschungsimpulse	☐	☐	☐	☐	☐	
- Ausbildungs-/Weiterbildungsmöglichkeit der Mitarbeiter unserer Unternehmung	☐	☐	☐	☐	☐	
- Rekrutierung von Hochschulabsolventen	☐	☐	☐	☐	☐	
- Zugang zur Grundlagenforschung der Hochschulen	☐	☐	☐	☐	☐	

Zugang zu den Forschungsergebnissen von Hochschulen ("codified knowledge")

- Patente/Lizenzen	☐	☐	☐	☐	☐	459
- Direkte Anwendung/Implementierung der Forschungsergebnisse der Hochschulen in der eigenen Unternehmung						
• zur Weiteranwendung im F&E-Bereich	☐	☐	☐	☐	☐	460
• zur Entwicklung neuer Produkte	☐	☐	☐	☐	☐	
• zur Entwicklung neuer Verfahren/Prozesse	☐	☐	☐	☐	☐	
- Zugang zur F&E-Infrastruktur von Hochschulen	☐	☐	☐	☐	☐	

Finanzielle Motive

- Kosteneinsparungen bei F&E	☐	☐	☐	☐	☐	464
- Reduktion des F&E-Risikos (technisches Risiko)	☐	☐	☐	☐	☐	
- Zeitersparnis bei F&E	☐	☐	☐	☐	☐	
- Ungenügende finanzielle Eigenmittel für eigenständige F&E	☐	☐	☐	☐	☐	
- Durchführung bestimmter F&E-Projekte nur in Kooperation mit Hochschulen möglich	☐	☐	☐	☐	☐	

Institutionelle/organisatorische Motive

- Aufbau eines neuen Forschungsbereiches	☐	☐	☐	☐	☐	469
- "Outsourcing" von F&E als strategische Massnahme	☐	☐	☐	☐	☐	
- Kooperation mit wissenschaftlichen Institutionen als Voraussetzung für öffentliche F&E-Förderungen	☐	☐	☐	☐	☐	
- Imageverbesserung durch Kooperation mit angesehenen Hochschulen	☐	☐	☐	☐	☐	
- Indirekter Zugang zum Wissen der Konkurrenten	☐	☐	☐	☐	☐	473
- Sonstige Motive, nämlich: _____						

6. Ergebnisse des Wissensaustauschs mit wissenschaftlichen Institutionen

6.1 Der Wissensaustausch hat geführt zur:

	ja	nein	
- Initiierung neuer Projekte im eigenen F&E-Bereich	☐	☐	518
- Entwicklung neuer Produkte	☐	☐	
- Entwicklung neuer Prozesse	☐	☐	

6.2 Der Wissensaustausch hat geführt zu:

	ja	nein	
- Wissenschaftlichen Publikationen	☐	☐	521
- Patenten	☐	☐	
- Lizenzen	☐	☐	

6.3 Die Humankapitalausstattung unseres F&E-Bereichs wurde aufgewertet:

	ja	nein	
- durch die Anstellung von Hochschul-Absolventen	☐	☐	524
- durch Weiterbildungsangebot, Sabbaticals etc.	☐	☐	

7. Hemmnisse für den Wissensaustausch mit wissenschaftlichen Institutionen

7.1 Welche **Hemmnisse** stehen dem Wissensaustausch mit wissenschaftlichen Institutionen (kurz: Hochschulen) entgegen bzw. verhindern, dass Ihre Unternehmung den Wissensaustausch intensiviert? (Mehrfachantworten möglich)

Fehlende Informationen

	keine Bedeutung 1	2	3	4	sehr grosse Bedeutung 5	
- Schwierigkeiten sich über die Forschungsaktivitäten an Hochschulen zu informieren	☐	☐	☐	☐	☐	526
- Schwierigkeiten geeignete Ansprechpartner an Hochschulen zu finden	☐	☐	☐	☐	☐	
- Schlechte Ausstattung der Schnittstelle zu Hochschulen (z.B. geringe Kapazität der Technologietransferstellen)	☐	☐	☐	☐	☐	

Fehlende Voraussetzungen für Austausch von Know-how in unserer Unternehmung

- Mangel an qualifiziertem Personal	☐	☐	☐	☐	☐	529
- Mangel an technischer Ausstattung	☐	☐	☐	☐	☐	
- Mangelndes Interesse an wissenschaftlichen Projekten	☐	☐	☐	☐	☐	
- Unsere F&E-Fragen sind für Hochschulen uninteressant	☐	☐	☐	☐	☐	

Fehlende Voraussetzungen für Austausch von Know-how bei den Partnern in den Hochschulen

	keine Bedeutung 1	2	3	4	sehr grosse Bedeutung 5	
- Mangel an wissenschaftlichem Fachpersonal für Wissensaustausch bei den Partnern in den Hochschulen (Kapazität)	☐	☐	☐	☐	☐	533
- Fehlendes unternehmerisches Denken der Partner bei den Hochschulen	☐	☐	☐	☐	☐	
- Zu wenig interessante Forschungsausrichtung der Hochschulen für unsere Unternehmung	☐	☐	☐	☐	☐	
- Keine Möglichkeit der kommerziellen Verwertung allfälliger Forschungsergebnisse	☐	☐	☐	☐	☐	

Kosten, Risiken/Unsicherheit

- Keine Garantie der Geheimhaltung von unserem Know-how von Seiten der Hochschulen	☐	☐	☐	☐	☐	537
- Notwendigkeit von umfangreichen Folgearbeiten für marktorientierte Implementierung der Forschungsergebnisse von Hochschulen	☐	☐	☐	☐	☐	
- Fehlende finanzielle Mittel in unserer Unternehmung für den Einsatz von Ressourcen für den Wissensaustausch	☐	☐	☐	☐	☐	
- Fehlende finanzielle Möglichkeiten der wissenschaftlichen Institutionen für Kooperation unter gleichen Bedingungen	☐	☐	☐	☐	☐	
- Ungenügende Effizienz/ Produktivität der Hochschulangehörigen im Vergleich zu den Beschäftigten unserer Unternehmung	☐	☐	☐	☐	☐	

	keine Bedeutung 1	2	3	4	sehr grosse Bedeutung 5	
- Technologische Abhängigkeit von externen Forschungsinstitutionen	☐	☐	☐	☐	☐	542
- Unsicherheit über das Kooperationsergebnis	☐	☐	☐	☐	☐	

Organisatorische/institutionelle Hemmnisse

- Aufwendige Verwaltungs- und Genehmigungsverfahren, gesetzliche Beschränkungen	☐	☐	☐	☐	☐	544
- Fehlende Unterstützung bei der Administration von Projekten seitens der Hochschule (z.B. durch Technologietransferstellen)	☐	☐	☐	☐	☐	
- Fehlende Unterstützung bei der kommerziellen Verwertung von Forschungsergebnissen seitens der Hochschule	☐	☐	☐	☐	☐	
- Probleme mit den Verfügungsrechten ("Property Rights")	☐	☐	☐	☐	☐	
- Managementprobleme bei der Projektorganisation auf Seiten der Hochschule (z.B. Koordinations- und Kommunikationsprobleme)	☐	☐	☐	☐	☐	
- Unterschiedliche Dringlichkeitsvorstellungen bei der Terminierung von Projekten	☐	☐	☐	☐	☐	
- Fehlende Vertrauensbasis	☐	☐	☐	☐	☐	
- Risiko des Reputationsverlustes	☐	☐	☐	☐	☐	551
- Sonstige Hemmnisse, nämlich:	_____					

***** Wir danken Ihnen für Ihre wertvolle Mitarbeit *****

Kontaktperson der Unternehmung: _____ Telefon: _____

Funktion Stellung: _____ E-Mail: _____

→ Für die Zustellung des Berichts, bitte E-mail angeben

Rückantwortadresse für Fenster-Couvert:

ETH Zürich
Konjunkturforschungsstelle
"Wissenstransfer"
WEC D 15
Weinbergstrasse 11
8092 Zürich

ETH Zürich
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Kontaktpersonen der KOF ETH Zürich

Marius Ley 044 632 85 33
inno@kof.ethz.ch

Bemerkungen:

_____

_____

_____

_____

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KOF

Questionnaire 2011
Knowledge and technology transfer between universities and the business sector in Switzerland

Survey of academic institutes

- All information provided will be handled in **strictest confidence**.
- Unless otherwise specified, answers relate to **locations in Switzerland** only
- If anything is unclear, please consult the explanatory notes
- Please place a cross in the relevant field ☒ or enter the appropriate figure
- The address for return is printed on the final page

Please return the questionnaire by

april 30, 2011

at the latest. (Please return the questionnaire even if you are unable to answer all the questions, or can only supply estimates.)

1. Information about your institute

1.1 Average **number of staff** at your institute (incl. director) during the year 2010 (part-time employees to be expressed as full-time equivalents):

[ ][ ][ ][ ][ ] (4)

1.2 At the end of 2010 the estimated breakdown into **categories of employees**, expressed as a proportion of total employment at your institute was as follows (part-time employees to be expressed as full-time equivalents):

- Professors	[ ][ ][ ] %
- Academic staff with doctorate and 'habilitation'	[ ][ ][ ] %
- Academic staff without doctorate	[ ][ ][ ] %
- Technical staff with university degree	[ ][ ][ ] %
- Staff carrying out other supporting and administrative functions	[ ][ ][ ] % (23)
Total staff	1 0 0

1.3 Total **budget** (including third-party funds) for your institute in the year 2010:

CHF [ ][ ][ ] [ ][ ][ ] [ ][ ][ ] (32)

1.4 a) Share of **third-party funds** in your institute's total budget for 2010:

[ ][ ][ ] % (33)

b) What was the **breakdown** of third-party funds in 2010?

- Proportion of third-party funds from business sector	[ ][ ][ ] % (36)
- Proportion of funds from foundations for the promotion of research and similar (e.g. KTI/CTI, SNF)	[ ][ ][ ] % (39)
Total third-party funds	1 0 0 %

1.5 What are the **focal areas of research** for your institute? (brief indications)

_____

_____

_____

_____

_____

_____

2. Teaching and research

2.1 Number of **theses** (at Swiss 'Diplom' level) completed in the three years 2008-2010:

41 ☐☐☐

Percentage of these theses conducted in **collaboration** with the **business sector**:

45 ☐☐☐ %

2.2 Number of **postgraduate degrees** (after Swiss 'Diplom') completed in the three years 2008-2010:

48 ☐☐☐

2.3 Number of doctoral **dissertations** completed in the three years 2008-2010:

51 ☐☐☐

Percentage of these doctoral dissertations conducted in **collaboration** with the **business sector**:

54 ☐☐☐ %

2.4 Number of research **publications** in the three years 2008-2010:

- in academic journals 57 ☐☐☐
- in magazines, newspapers etc. 60 ☐☐☐

2.5 Has your institute (or individual staff members) achieved research results that led to a **patent application** in the three years 2008-2010?

63 yes ☐ no ☐

If yes, how many? approx.: 64 ☐☐☐☐

- Percentage of these patent applications achieved in collaboration with the business sector: 68 ☐☐☐ %

2.6 Did your institute give out **licences** in the three years 2008-2010?

71 yes ☐ no ☐

If yes, how many? approx.: 72 ☐☐☐☐

2.7 Did your research results lead to **spin-offs/start-ups** in three years 2008-2010?

76 yes ☐ no ☐

If yes, how many? approx.: 77 ☐☐☐☐

2.8 What percentage of the **working time** of academic staff in your institute is devoted to the following activities, on average (estimations if necessary):

- teaching	☐☐☐ %
- basic research	☐☐☐ %
- more applied research	☐☐☐ %
- other tasks	☐☐☐ % 92
Total working hours	1 0 0 %

3. Forms of knowledge and technology transfer between institutes and the business sector, and channels used

3.1 Did your institute conduct activities designed to promote **knowledge and technology transfer** to Swiss companies

a) in the three years 2005-2007	93 yes ☐	no ☐
b) in the three years 2008-2010	94 yes ☐	no ☐

c) Were there any activities in 2008-2010 designed to promote knowledge and technology transfer to foreign companies outside Switzerland?

yes ☐ no ☐

If yes:

96 ☐ EU ☐ USA

98 ☐ Japan ☐ Other countries: _____

Knowledge and technology transfer between academic institutes and the business sector should be understood as any activities aimed at transferring knowledge and technology that may help either the company or the academic institute - depending on the directing of transfer - to further its activities.

Knowledge and technology transfer covers a wide range of different activities. These are listed in **question 3.2**.

→ **If the answer to a) and b) is no, please proceed to question 6.**

3.2 What **forms** does knowledge and technology transfer between your institute and the business sector take, and how important are these forms for your institute (more than one answers possible)?

Informal contacts, personal network of contacts

	not important 1	2	3	4	extremely important 5
- informal contacts (e.g. by phone, email) with employees from business sector for information exchange	☐	☐	☐	☐	☐ 100
- attending business sector conferences, exhibitions, workshops etc.	☐	☐	☐	☐	☐
- reading or quoting the academic publications of business sector research laboratories	☐	☐	☐	☐	☐

	not important				extremely important	
Technical facilities	1	2	3	4	5	
- joint laboratories	☐	☐	☐	☐	☐	103
- use of technical facilities or research centres at business sector R&D departments	☐	☐	☐	☐	☐	
Training, further education, staff mobility						
- contacts with graduates employed in the business sector	☐	☐	☐	☐	☐	105
- contacts with former staff employed in the business sector	☐	☐	☐	☐	☐	
- student participation in corporate R&D projects	☐	☐	☐	☐	☐	107
- allocating thesis projects in collaboration with the business sector	☐	☐	☐	☐	☐	
- allocating doctoral projects in collaboration with the business sector	☐	☐	☐	☐	☐	
- engagement of business sector scientists in your institute's own R&D projects	☐	☐	☐	☐	☐	
- joint teaching courses or programmes	☐	☐	☐	☐	☐	111
- teaching assignments for business sector staff	☐	☐	☐	☐	☐	
- attendance of specialised courses or training programmes of the institute by business sector scientists	☐	☐	☐	☐	☐	
Research						
- research projects in collaboration with the business sector (partially or fully funded by the business sector)	☐	☐	☐	☐	☐	114
- longer-term research contracts with the business sector (contract research)	☐	☐	☐	☐	☐	
- research consortiums (with at least one company participating)	☐	☐	☐	☐	☐	
Consulting						
- Expertises/reports for the business sector	☐	☐	☐	☐	☐	117
- Consulting for the business sector	☐	☐	☐	☐	☐	

3.3 How important are the following institutions in **mediating** formal contacts with the business sector?

	not important				extremely important	
	1	2	3	4	5	
- your university's technology transfer office	☐	☐	☐	☐	☐	119
- the Swiss Innovation Promotion Agency (KTI/CTI)	☐	☐	☐	☐	☐	
- the Swiss National Science Foundation (SNF)	☐	☐	☐	☐	☐	
- European Union (EU) Framework Programmes	☐	☐	☐	☐	☐	
- other EU research programmes	☐	☐	☐	☐	☐	123

other institutions, i.e _____

3.4 How important are the following **media** for knowledge and technology transfer with the business sector?

	not important				extremely important	
	1	2	3	4	5	
- academic publications	☐	☐	☐	☐	☐	124
- patents	☐	☐	☐	☐	☐	
- licenses	☐	☐	☐	☐	☐	
- spin-offs/start-ups	☐	☐	☐	☐	☐	

4. Motivation and objectives for knowledge and technology transfer with the business sector

4.1 What is your motivation and what are your objectives in going into knowledge and technology transfer arrangements with private companies, and how important are they for the activities of your institute? (more than one answer possible)

Financial motives	not important				extremely important	
	1	2	3	4	5	
- cost savings in research projects	☐	☐	☐	☐	☐	128
- time savings in research projects	☐	☐	☐	☐	☐	
- resources for expanding basic research	☐	☐	☐	☐	☐	
- resources for extending research facilities	☐	☐	☐	☐	☐	
- commercial success	☐	☐	☐	☐	☐	
- resources from business can be used more flexibly than public funding	☐	☐	☐	☐	☐	
- collaboration with business as a reference when applying for more public funding	☐	☐	☐	☐	☐	
- certain applied research projects can only be carried out in collaboration with companies	☐	☐	☐	☐	☐	135

Access to human capital, person-related knowledge ('tacit knowledge')

	not important 1	2	3	4	extremely important 5	
- access to specific capabilities to supplement expertise within the institute	☐	☐	☐	☐	☐	136
- new research impetus	☐	☐	☐	☐	☐	
- exchange of ideas and experiences with industrial researchers	☐	☐	☐	☐	☐	
- practical experience for institute staff and/or students	☐	☐	☐	☐	☐	
- gaining additional research insight in the institute's own area of research	☐	☐	☐	☐	☐	

Access to business sector research findings ('codified knowledge')

- patents, licenses	☐	☐	☐	☐	☐	141
- gaining knowledge about practical problems for curriculum	☐	☐	☐	☐	☐	

Access to business sector R&D facilities

- access to business sector technological equipment or specialised technology	☐	☐	☐	☐	☐	
- opportunity to test own research findings in practice	☐	☐	☐	☐	☐	

Institutional or organisational motives

- securing good job prospects for students and/or institute staff in the business sector	☐	☐	☐	☐	☐	145
- securing the presence of business representatives in the university's academic consultant bodies	☐	☐	☐	☐	☐	
- extending the university's mission	☐	☐	☐	☐	☐	
- promoting the diffusion of a particular technology	☐	☐	☐	☐	☐	
- diffusing key R&D findings amongst the public	☐	☐	☐	☐	☐	
- promoting regional development	☐	☐	☐	☐	☐	
- improving the image of science	☐	☐	☐	☐	☐	151

- other motives, i.e. _____

5. Impact of knowledge and technology transfer with the business sector

5.1 Has the financial position of your institute changed as a result of the knowledge and technology transfer?

- no change ☐ 152
- additional resources for research ☐
- additional resources for teaching ☐
- additional resources for technical facilities ☐

5.2 Has the research orientation of your institute changed as a result of the knowledge and technology transfer?

- no change ☐ 156
- more geared to applied research ☐
- more geared to basic research ☐

5.3 Has the knowledge and technology transfer affected teaching, further education or further training activities at your institute?

- no impact ☐ 159
- education provided is more geared towards practice ☐
- less time available for teaching and student support ☐

5.4 Has the scientific reputation of your institute changed as a result of the knowledge and technology transfer?

- no change ☐ 162
- better reputation ☐
- worse reputation ☐

6. Obstacles to knowledge and technology transfer with the business sector

6.1 What obstacles prevent knowledge and technology transfer with business companies and/or what obstacles prevent your institute from intensifying the process of knowledge and technology transfer? (more than one answer possible)

Lack of information

	not important 1	2	3	4	extremely important 5	
- difficult to get informed about research activities in the business sector (confidentiality)	☐	☐	☐	☐	☐	165
- difficult to find an appropriate partner in the business sector	☐	☐	☐	☐	☐	
- interface to the business sector poorly equipped (e.g. technology transfer offices lack capacity)	☐	☐	☐	☐	☐	

Problems in the areas of teaching, basic research

- teaching requires too much time	☐	☐	☐	☐	☐	168
- scientific independence impaired	☐	☐	☐	☐	☐	
- hindrance to academic publication activities	☐	☐	☐	☐	☐	
- neglecting basic research	☐	☐	☐	☐	☐	

Necessary conditions for transfer of know-how lacking amongst potential partners in the business sector

	not important 1	2	3	4	extremely important 5	
- lack of qualified staff on the part of companies	☐	☐	☐	☐	☐	172
- lack of technical facilities on the part of companies	☐	☐	☐	☐	☐	
- lack of interest in scientific projects on the part of companies	☐	☐	☐	☐	☐	
- insufficient interesting research questions in the business sector for our institute	☐	☐	☐	☐	☐	

Necessary conditions for transfer of know-how lacking in our institute

- lack of academic specialists for knowledge and technology transfer (capacity)	☐	☐	☐	☐	☐	176
- approach of institute staff not entrepreneurial enough	☐	☐	☐	☐	☐	
- our research focus is not interesting enough for the industry sector	☐	☐	☐	☐	☐	
- no possibility of commercialising our research findings	☐	☐	☐	☐	☐	

Costs, risks, uncertainty

- uncertainty about R&D results	☐	☐	☐	☐	☐	180
- industry has different ideas on costs and/or productivity	☐	☐	☐	☐	☐	
- R&D budgets of potential business partners are too low	☐	☐	☐	☐	☐	

Organisational, institutional obstacles

	not important 1	2	3	4	extremely important 5	
- resource-intensive administrative and approval procedures, legal restrictions	☐	☐	☐	☐	☐	183
- lack of project administration support on the part of the academic institution (e.g. through technology transfer offices)	☐	☐	☐	☐	☐	
- lack of support for the commercialisation of research findings on the part of the academic institution	☐	☐	☐	☐	☐	
- Property Rights problems	☐	☐	☐	☐	☐	
- project management problems on the part of the academic institution (e.g. coordination or communications problems)	☐	☐	☐	☐	☐	
- different views on urgency with regard to the scheduling of projects	☐	☐	☐	☐	☐	
- lack of confidence	☐	☐	☐	☐	☐	
- risk of putting a reputation at stake	☐	☐	☐	☐	☐	190
- other obstacles, i.e _____						

***** Thank you for your valuable assistance *****

Contact person at institute: _____ Phone no: _____

Position: _____ E-mail: _____

→ **Please provide your E-Mail in order to send you the report**

Comments on the questionnaire

_____

_____

_____

_____

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