Chapter 3
The Role of Research Orientation for Attracting Competitive Research Funding*

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Abstract This article studies the role of research orientation for attracting research grants at higher education institutions in Germany. Traditionally research activities were funded by the institutions' core budget. More recently, extramural research funding has become increasingly important. Besides the public sector, industry provides a growing share of such funds. The results based on a sample of professors in science and engineering suggest that basic and applied research is complementarity for attracting research funding from industry. Thus, professors who conduct basic research in addition to research on the applicability of their results appear to be most successful in raising industry funds. For raising grants from public sources, it turns out that specialization is more important. Specialized research units on either basic or applied research obtain significantly more public grants which points to a substitutive relationship between basic and applied research for grants from public sources.

1 Introduction

Based on the idea that university systems with competitive funding mechanisms provide output incentives and are consequently more efficient and productive than traditional funding environments, university research throughout Europe is

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increasingly funded by a mix of "fixed" institutional budget and project-based funds (Auranen and Nieminen 2010). Industrial grants provide an increasing share of such extramural funds (OECD 2007, 2009). Besides the growing role of funding from the private business sector, public research funding is also becoming increasingly competitive. The rules and precepts according to which such funds are granted may naturally differ between schemes and sponsors. This chapter aims to contribute to the understanding of how university research matches industry demands for scientific knowledge by analyzing the role of research orientation for the attraction of competitive research funding and how it is different for public sector grants.

While previous literature found academic research to be highly valuable for industrial innovation (Mansfield 1991, 1995; Cohen et al. 2002; Cassiman et al. 2008), the direction of research that is most beneficial and therefore more likely to be sponsored has not been studied as extensively. Do firms benefit from sourcing basic science that is not feasible or unprofitable to build up themselves? Or do they seek access to rather applied research that provides knowledge that is closer to applicable technology and thus closer to marketable innovations?

Previous studies did shed some light on the question which fields of science were particularly interesting for certain industries and on the importance of geographical proximity and faculty quality for getting funded by industry (Mansfield 1995; Mansfield and Lee 1996). At the university level, Ljungberg (2008) finds that mainly larger and highly specialized universities in Sweden attract most industry funding relative to their size. The larger but less specialized universities and most of the smaller regional colleges and universities receive less. Thus, he sees specialization in research as an important characteristic for explaining differences in the ability to attract private-sector funding. Anders Broström (2012), on the other hand, finds in a study on firms collaborating with major Swedish universities that these firms collaborate with university researchers in order to access academic networks and to strengthen skills of their employees, i.e. to increase absorptive capacity for knowledge spillovers in general, not only from science. This may suggest that firms are less interested in highly specialized research units but in those that provide a variety of skills.

The reason for the lack of evidence in the literature at the laboratory level so far could be rooted in the seemingly obviousness of the question who gets such funding. As argued by Trajtenberg et al. (1997), industry research and development (R&D) is directed at commercial success, while university research focuses on solving fundamental scientific questions. Thus, it seems obvious to assume that firms fund university research labs to gain access to such basic research that complements their own application-oriented R&D.

However, firms cannot absorb scientific knowledge without effort. Investments in absorptive capacities may be crucial. The extent of such investments may depend on whether firms source solely basic research or whether they are able to contract researchers with applied research skills. Consequently, it could be argued that as applied science is easier to identify and exploit for industry and involves lower monitoring costs (Thursby and Thursby 2004), instead of sourcing pure basic research results, firms could target university research that has passed a certain threshold of applicability and is consequently less costly to adopt. Moreover, sourcing applied research reduces the "distance" from basic science to applicable technology that may be especially large for early-stage technologies (Thursby et al. 2007).

As both arguments are straightforward, one could reason that firms prefer those researchers as collaboration partners whose labs are capable of doing both basic as well as applied research especially if the joint research evolves through different stages of maturity. If the latter argument applies empirically, we would expect to find a complementary relationship between basic and applied research orientation.

Another question that arises is whether research orientation plays a different role for the successful acquisition of public grants as compared to industry funds. The rationale behind public research funding has traditionally been based on the positive externalities from basic science. Public funding for applied research, on the other hand, has usually been linked to public-private research partnerships and has been justified by the resulting economic benefits from such collaboration (Czarnitzki 2009). Given the limits of public funds, award criteria generally revolve around academic excellence to ensure highest possible returns to society (Viner et al. 2004; Sorenson and Fleming 2004). Excellence, however, may require a high degree of specialization in order to achieve an accumulative advantage at the level of the individual researcher or the research team.

This chapter adds to previous research by studying the role of research orientation, i.e., basic versus applied research, for attracting competitive research funding from the private as well as from the public sector. The sample of 669 research units at 46 higher education institutions in Germany covers a broad range of disciplines in science and engineering. The results suggest that basic and applied research is complementary for raising funds from industry. Professors whose labs conduct both types of research attract most funding from industry in contrast to those who are focused on either basic or applied research, both in monetary terms as well as in percent of their total research budget. For raising grants from public sources, on the other hand, specialization seems more important. Specialized research units on either basic or applied research obtain significantly more public grants pointing to a substitutive relationship between basic and applied research for such grants.

This chapter proceeds as follows. Section 2 describes the data and sets out the empirical framework. Section 3 presents the econometric analysis and the results. Section 4 concludes and points out roads for further research.

2 Data and Empirical Framework

The unit of analysis is the research lab for which data has been collected from different sources. First, a survey among research units at German higher education institutions in the fields of science or engineering was conducted by the Centre for European Economic Research (ZEW, Mannheim) in the year 2000. In the survey, university professors indicated the percentage of their units' research that is directed at basic research (*BASIC_SHARE*) or applied research (*APPLIED_SHARE*). Moreover, the amount of private-sector research grants received during the year 1999 both in monetary terms (*INDFUND*) as well as share of their overall budget

(*INDSHARE*) and the corresponding information on public grants (*GOVFUND*, *GOVSHARE*) is obtained immediately from the survey.[1]

To control for other important determinants of research funding, the survey data is supplemented with additional information from different data sources. Most importantly, the previous scientific performance of the research units' heads may also impact the attraction of grants (e.g., Murray 2002; Viner et al. 2004). Past scientific publications (*PUBS*) as well as citations to these publications (*CIT_PUBS*) have been collected from the ISI Web of Science® database. In addition, information on patent applications (*PATS*) on which the respective professor was listed as inventor and forward citations to these patents (*CIT_PATS*) were drawn from the database of the German Patent and Trade Mark Office (DPMA).[2] We limit the time frame ("activity window") for both publications and patents to the period from 1994 to 1999. As the effectiveness with which a research unit attracts third-party funding may depend on the head's experience or seniority, information on the year in which the professor received his Ph.D. had been gathered from the German National Library, and his academic experience was calculated (*EXPER*). To test for any nonlinear life-cycle effect (Levin and Stephan 1991), the squared value ($EXPER^2$) is included. For differences in the size of the different institutions is controlled for by including the (logged) total number of students (*UNI_SIZE*). Larger universities may, for instance, be more visible to funding agencies and to industry and thus attract relatively more third-party funding. A squared term is included to control for nonlinearity. A dummy is included accounting for whether the professor had collaborated with his institution's Technology Transfer Office (*TTO*). We account for differences between research fields by utilizing seven field dummies (see Table 3.5 for key variables by research field). Three institution-type dummies are added to capture differences in funding patterns between general universities, technical universities, and polytechnic colleges. Finally, we include a gender dummy (*FEMALE*) for the head of the department. The final sample contains 669 professor-research unit observations from 46 different institutions of which are 56% universities, 23% technical universities, and 21% polytechnics. Table 3.1 shows descriptive statistics for the main variables of interest.[3]

Research units in the sample obtained about 96.5 thousand Euros from industry on average. This makes up for 8.6% of their total budgets in 1999. Grants from public sources amounted to about 120 thousand Euros on average or about 22% of their total budgets. Research units spend on average 42% of their time on basic research. The share is higher at universities (57%) and considerably lower at polytechnics (4%).

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[1]The sum of INDFUND and GOVFUND is 'total third-party funding'. Adding this to the 'core' institutional funding (COREFUND) yields the units' overall funding: TOTALFUND = INDFUND + GOVFUND + COREFUND.

[2]Patent forward citations have been shown to be a suitable measure for the quality, importance, or significance of a patented invention and have been used in various studies (see, e.g. Henderson et al. 1998; Hall et al. 2001).

[3]Cross-correlations between the main variables are presented in Table 3.4.

Table 3.1 Descriptive statistics (699 obs)

Variable	Description	Mean	Std. Dev	Min	Max
Grant-based funding					
$INDFUND_t$	T €	96.43	219.90	0	2,129.53
$INDSHARE_t$	% of total budget	8.61	13.48	0	100
$GOVFUND_t$	T €	118.31	244.44	0	1,844.53
$GOVSHARE_t$	% of total budget	21.71	20.22	0	100
Research orientation					
BASIC_SHARE	%/100	0.42	0.34	0	1
APPLIED_SHARE	%/100	0.58	0.34	0	1
Controls					
$PUBS_{t\text{-}6\ to\ t}$	Publication count	11.08	20.51	0	243
$PUBCITS_{t\text{-}6\ to\ t}$	Citation count	228.16	571.22	0	5,907
$PATS_{t\text{-}6\ to\ t}$	Patent count	1.41	3.48	0	32
$PATCITS_{t\text{-}6\ to\ t}$	Citation count	20.25	126.61	0	2,634
UNI_SIZE	Student count	17,789.40	11,817.00	1,451	59,599
EXPER	Years since Ph.D.	21.64	8.68	1	43
TTO	Dummy	0.73	0.44	0	1
FEMALE	Dummy	0.03	0.18	0	1

Note: Institution-type dummies and field dummies not presented. Note also that the time period for the controls for past scientific includes t as articles published in t have usually been written in the years up to t, thus reflecting research outcomes of the period t-1 or earlier. The same applies to patents applied for in t.

At technical universities, the average share time spent on applied research is 62%. The relative focus on applied research naturally differs between fields of research. Electrical engineering, mechanical engineering and other engineering report high shares of 79%, 77%, and 74%, respectively. Research units in chemistry and physics spend about 61% and 69% of their time of basic research, while and mathematicians and computer scientists and biologists have basic research shares of 56% and 50%, respectively. Professors in the sample published on average 11 items in the period 1994–1999 and occurred 1.4 times as inventor on a patent application. The numbers vary by research field and type of institution (see Table 3.5). The size of the institutions differs in student numbers ranging from 1,451 to nearly 60 thousand students. The share of scientists of a unit's total staff is 73% on average. The share is slightly lower at polytechnics (68%) and technical universities (71%). The professors have an average experience of about 22 years in academe. Seventy three percentage of them had some form of contact to a TTO, and only 3% of them are female.

3 Econometric Analysis and Results

The research unit's amount of industry funding (*INDFUND,* and the share of this funding as % of the total budget *INDSHARE*) and the amount and share of public grants (*GOVFUND*, *GOVSHARE*) serve as dependent variables. However, not all professors in the sample attracted third-party funds. Tobit models are being estimated to account for this censoring bias. The models to be estimated can be written as

$$Y^* = X'\beta + \varepsilon, \tag{3.1}$$

where the unobserved latent variable Y^* is equal to *INDSHARE* and *GOVSHARE* in the first set of models and to the logarithm of *INDFUND* and *GOVFUND* (+1), respectively, in the second set of specifications. The observed dependent variable is equal to

$$Y = \begin{cases} Y^* \text{ if } X'\beta + \varepsilon > 0 \\ 0 \text{ otherwise} \end{cases} . \tag{3.2}$$

X represents the matrix of regressors, β the parameters to be estimated and ε the random error term.[5] The main hypothesis concerns the effects of a unit's research orientation on third-party funding. To test for complementarity between the two, an interaction term *BASIC*APPLIED* is added to the model. As *BASIC_SHARE* and *APPLIED_SHARE* add up to 1, it is necessary to multiply the individual shares with the number of scientific staff (mean = 13, median = 9, and the maximum number is 130).[4] After the core specification, we add the research track record of units' heads (*PUBS* and *PATS*) and the gender dummy (*FEMALE*). Due to the skewed distributions of patents and publications, the logs of these variables are included. For those with zero patents or publications, i.e., if the log is not defined, a dummy variable is included to capture the "quasi-missing" values (*NO_PUB_DUM*, *NO_PAT_DUM*).

Table 3.2 presents the regression results. They show that basic research is associated with a lower share of funding from industry, whereas applied research has a significantly positive effect in all three specifications. The latter confirms findings by Gulbrandsen and Smeby (2005) who study differences in research orientation between university professors with industry funding and professors with other types of funding or no external research funding. They find support in their Norwegian data for the hypothesis that professors with industrial funding indeed describe their research more often as applied than professors without funding from the private sector.

The inclusion of the interaction term reveals that research units which do both basic as well as applied research have a larger share of industry grants compared to

[4] This transformation results in a shift in interpretation of the variable from 'share of effort devoted to basic or applied research' to 'staff working on basic or applied research'. Thus, it ought to be kept in mind for the interpretation of the results that these variables (*BASIC* and *APPLIED)* also measure lab size.

[5] The standard Tobit model requires the assumption of homoscedasticity; otherwise, the estimates are inconsistent (cf. Greene 2000). Tests on heteroscedasticity (Wald tests and LR tests) using a heteroscedastic specification of the Tobit model in which the homoscedastic standard error σ was replaced with $\sigma i = \sigma \exp(Z'\alpha)$ in the likelihood function find indeed evidence of heteroscedasticity. Consequently, regional dummies, one for each of the 16 German states, and field and institution-type dummies were used to model group-wise multiplicative heteroscedasticity. The presented estimation results are thus obtained from heteroscedastic-consistent estimations.

Table 3.2 Tobit regressions on source of funding as share of total budget (669 obs.)

Variable	Tobit models on *INDSHARE*			Tobit models on *GOVSHARE*		
BASIC	–0.153*	–0.323**	–0.320**	0.252**	0.538***	0.454***
	(0.085)	(0.132)	(0.137)	(0.120)	(0.169)	(0.173)
APPLIED	0.321***	0.229**	0.196***	0.344***	0.516***	0.519***
	(0.082)	(0.090)	(0.085)	(0.125)	(0.160)	(0.172)
*BASIC*APPLIED*		0.013**	0.013**		–0.019***	–0.017***
		(0.006)	(0.006)		(0.006)	(0.006)
EXPER	0.275	0.296	0.287	0.854*	0.783	0.835
	(0.333)	(0.340)	(0.305)	(0.512)	(0.512)	(0.521)
$EXPER^2$	–0.010	–0.010	–0.009	–0.018	–0.017	–0.017
	(0.007)	(0.008)	(0.007)	(0.012)	(0.012)	(0.012)
TTO	3.927***	4.136***	3.404**	3.032	2.689	2.461
	(1.516)	(1.542)	(1.498)	(2.022)	(2.032)	(2.055)
ln(*UNI_SIZE*)	93.573***	91.531***	88.936***	16.759	24.552	22.597
	(31.572)	(31.084)	(31.477)	(35.785)	(37.710)	(37.579)
ln(UNI_SIZE^2)	–4.903***	–4.771***	–4.612***	–0.686	–1.139	–1.007
	(1.653)	(1.627)	(1.649)	(1.879)	(1.975)	(1.970)
ln(PUBS)			–0.729			1.928**
			(0.712)			(0.924)
ln(PATS)			0.914			1.862
			(1.120)			(1.676)
NO_PUB_DUM			–1.538			–0.281
			(1.884)			(2.863)
NO_PAT_DUM			–3.450**			2.997
			(1.721)			(2.307)
FEMALE			0.076			2.209
			(2.189)			(4.838)

(continued)

Table 3.2 (continued)

Variable	Tobit models on *INDSHARE*			Tobit models on *GOVSHARE*		
Joint significance of institution dummies χ^2 (2)	29.66***	26.89***	21.60***	25.97***	26.41***	24.96***
Joint significance of field dummies χ^2 (6)	42.16***	41.27***	31.68***	32.09***	33.15***	30.35***
Joint significance of *Länder* dummies χ^2 (15)	88.38***	84.37***	99.21***	51.94***	48.85**	51.83***
Log-likelihood	−1,855.67	−1,853.78	−1,851.48	−2,410.06	−2,406.32	−2,402.02
# of censored obs	260			147		

Notes: All models include a constant, institution-type and field dummies. The heteroscedasticity term includes six field dummies, 15 *Länder* dummies, and two institution-type dummies. *** (**, *) indicate a significance level of 1% (5%, 10%).

more specialized units. On the contrary, the models on *GOVSHARE* show a negative sign for the interaction term which indicates a substitutive relationship between basic and applied research for the attraction of public grants. As expected, contact to a TTO increases industry funding, but has no effect on public grants. The share of industry grants is higher at larger institutions up to a size of about 14,000 students but is decreasing with the number of students at larger institutions. Moreover, having no past "patenting experience" reduces the share of industry grants. The coefficient of the variable capturing past publications has the expected positive sign for public grants pointing to the importance of scientific achievements for raising such funds. Past patent applications are not significant for the share or amount of public grants.

In a section step, models on the total amount of grants (*GOVFUND*) instead of the share of total budget are estimated in order to be able to calculate more meaningful marginal effects. The key insights are confirmed (Table 3.3). Here, the estimated coefficients describe the marginal effects of the regressors on Y^*, such that

$$\frac{\partial E\left[Y_i^* | x_i^{'}\right]}{\partial x_{ik}} = \beta_k. \tag{3.3}$$

(see, e.g., Greene 2000: 908–910). Since the dependent variable in this model is specified as logarithm, a unit change in our main variables of interest, i.e., *BASIC* and *APPLIED*, can be interpreted as a percentage change in funding. If one additional person works on applied research, industry funding (in terms of the latent index Y^*) increases by 8.1% and public grants by 10.8% (Table 3.3, specification 3.3). If an additional basic researcher is hired, government grants (column 6) increase by about 10%, all else constant.

As a robustness check, all models have been estimated accounting for quality-weighted measures of past research performance. The results confirm previous findings. The total number of citations to past publications (in the pre-sample period 1994–1999) is positive and significant in the *GOVFUND* equation but insignificant for *INDFUND*. The same applies for citations per publication. It is noteworthy that the marginal effects are larger for the quality-weighted measures for scientific output. Thus, the quality of scientific output seems not only to be important but also to be more important for public grants than for industry grants.

4 Conclusions

Given the increasing share of competitive grants—from public as well as private-sector sources—supplementing universities core funding, the objective of this chapter was to provide an analysis of the role of direction of faculty research in terms of basic versus applied research for attracting such grants. Although we see that applied research indeed increases the share of industry funding of the research units' total

Table 3.3 Tobit regressions on source of funding (669 obs)

Variable	Tobit models on ln (*INDFUND* +1)			Tobit models on ln (*GOVFUND* +1)		
BASIC	0.007	–0.025	–0.027	0.063***	0.105***	0.098***
	(0.015)	(0.027)	(0.027)	(0.013)	(0.016)	(0.015)
APPLIED	0.101***	0.086***	0.081***	0.083***	0.107***	0.108***
	(0.018)	(0.020)	(0.020)	(0.009)	(0.013)	(0.013)
*BASIC*APPLIED*		0.002*	0.002**		–0.003***	–0.002***
		(0.001)	(0.001)		(0.001)	(0.001)
EXPER	0.036	0.042	0.041	0.080*	0.063	0.074
	(0.070)	(0.072)	(0.071)	(0.046)	(0.044)	(0.045)
$EXPER^2$	–0.001	–0.001	–0.001	–0.002	–0.001	–0.001
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
TTO	1.134***	1.174***	1.016***	0.545***	0.468***	0.457***
	(0.312)	(0.317)	(0.323)	(0.175)	(0.169)	(0.170)
ln(UNI_SIZE)	7.347	6.639	5.575	1.714	2.816	2.170
	(5.289)	(5.256)	(5.246)	(3.454)	(3.597)	(3.672)
$ln(UNI\_SIZE^2)$	–0.367	–0.325	–0.264	–0.067	–0.129	–0.094
	(0.279)	(0.278)	(0.278)	(0.180)	(0.187)	(0.191)
ln(PUBS)			–0.058			0.248*
			(0.131)			(0.133)
ln(PATS)			0.126			0.096
			(0.202)			(0.075)

NO_PUB_DUM			−0.310			−0.302
			(0.379)			(0.256)
NO_PAT_DUM			−0.692**			0.327
			(0.311)			(0.211)
FEMALE			0.141			0.164
			(0.672)			(0.512)
Joint significance of institution dummies χ^2 (2)	17.17***	17.19***	15.52***	36.18***	75.89***	79.39***
Joint significance of field dummies χ^2 (6)	59.18***	53.72***	43.59***	75.50***	38.06***	36.13***
Joint significance of *Länder* dummies χ^2 (15)	52.41***	50.34**	48.61**	71.77***	77.21***	74.19***
Log-likelihood	−1,184.01	−1,182.23	−1,179.05	−1,162.25	−1,152.80	−1,147.28
# of censored obs	260			147		

Notes: All models include a constant, institution-type and field dummies. The heteroscedasticity term includes six field dummies, 15 *Länder* dummies, and two institution-type dummies. *** (**, *) indicate a significance level of 1% (5%, 10%).

budgets as well as the amount, the complementarity between basic and applied research for success in raising industry grants suggests that researchers who provide basic scientific input as well as competencies on the applicability of such are most attractive targets for funding from the business sector. Thus, firms appear to seek access to basic science that is not feasible or not profitable to build up in-house but also rely on the scientists' ability to translate it into applicable technology. This points to a trade-off faced by the sponsoring firm between the advantage of sourcing basic science from universities and the costs of building absorptive capacities to effectively use this knowledge. Collaborating with university research labs that are able to conduct both basic as well as applied research may reduce these costs and, hence, alleviate the trade-off.

With respect to public grants, the results suggest that public funding-authorities prize specialization. Research units with either a strong focus on either basic or on applied research raise significantly more grants than others. This is in line with previous findings. Application-oriented research, for instance, has been shown to benefit from supranational funding programs such as the EU-wide "Framework Programme for Research and Development". In Germany, direct project funding by the federal government has been to an increasing extent directed at promoting industry-science consortia that aim explicitly at promoting applied research. Grant programs by the German Research Foundation (DFG), on the other hand, may support rather basic research agendas as they attract applicants with particular high scientific excellence if measured in publications and citations (Grimpe 2010). Moreover, the result that private-sector and public grants are subject to different criteria with respect to research orientation suggests that industry grants offer an additional source of competitive funding for research units that may not be willing or not be able to raise other types of grants. What is more, worries about a "funding split" in the sense that industry only provides grants for applied research and government only promotes basic research may be exaggerated - at least in the short run.

However, the results ought to be interpreted with the study's limitations in mind. Given the available data, it was not possible to account for the dynamics between ex ante research orientation that shapes the attractiveness for receiving industry funding and the incentives to adopt a certain orientation to become more attractive for funding in the future. Panel data on a set of professors and their research unit would be desirable for such an exercise. Further analysis would, moreover, not only benefit from distinguishing between types of public grants but also from studying the providers of industry grants in greater detail. As results for the USA by Cohen et al. (2002) suggest, it is very likely that the observed effects differ substantially between industries, firms of different sizes and different stages of maturity. Further research should also take into account the impact of "outside factors" such as government-subsidized cost sharing in public-private partnerships and their effects of industry-funded university research that may also cross-impact the researchers' attention to other public funding schemes.

5 Appendix

Table 3.4 Cross-correlations matrix between main variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 INDSHARE	1															
2 INDFUND	0.532*	1														
3 GOVSHARE	−0.082	0.034	1													
4 GOVFUND	0.083	0.439*	0.572*	1												
5 BASIC	−0.303*	−0.163*	0.303*	0.018	1											
6 APPLIED	0.303*	0.163*	−0.303*	−0.018	−1.000*	1										
7 PUB	−0.119*	−0.056	0.182*	0.067	0.369*	−0.369*	1									
8 PAT	0.103*	0.158*	0.045	0.146*	−0.058	0.058	0.034	1								
9 PUBCITS	−0.123*	−0.063	0.196*	0.062	0.349*	−0.349*	0.802*	0.011	1							
10 PATCITS	0.098	0.289*	−0.022	0.084	−0.023	0.023	0.003	0.502*	0.004	1						
11 UNI_SIZE	−0.046	0.035	0.274*	0.192*	0.428*	−0.428*	0.187*	−0.043	0.178*	0.004	1					
12 TOT_STAFF	0.037	0.487*	0.151*	0.499*	0.022	−0.022	0.102*	0.099	0.068	0.136*	0.127*	1				
13 SCI_STAFF	−0.186*	−0.200*	0.192*	−0.012	0.247*	−0.247*	0.122*	−0.039	0.135*	−0.073	0.123*	−0.188*	1			
14 EXPER	0.009	0.004	0.150*	0.054	0.197*	−0.197*	0.080	−0.020	0.015	−0.073	0.186*	0.054	−0.002	1		
15 TTO	0.147*	0.119*	0.002	0.131*	−0.297*	0.297*	−0.107*	0.125*	−0.065	0.074	−0.152*	0.115*	−0.155*	0.020	1	
16 GENDER	−0.030	−0.055	−0.014	−0.060	−0.031	0.031	−0.029	−0.015	−0.027	−0.011	−0.004	−0.069	−0.001	−0.055	0.036	1

*Significant at 1% level

Table 3.5 Grants, research orientation, and research performance by research fields and institution type (means)

Field	# of obs.	GOVSHARE	GOVFUND	INDSHARE	INDFUND	PUB	PUBCITS	PAT	PATCITS
Physics	101	32.03	149.72	4.29	45.68	22.90	627.76	1.13	17.61
Maths and computer science	107	16.46	60.51	5.95	39.09	3.97	44.48	0.21	0.84
Chemistry	95	22.10	82.22	6.06	68.05	27.52	513.24	1.80	23.24
Biology	57	24.43	77.03	7.59	29.10	3.05	324.81	0.93	7.73
Electrical engineering	101	14.76	108.83	11.53	130.76	11.58	53.88	2.27	33.74
Mechanical engineering	108	21.68	174.52	14.00	205.35	3.93	27.06	1.84	40.39
Other engineering	100	22.00	155.84	10.05	123.51	6.73	88.38	1.57	12.59
Universities	371	26.25	129.02	7.51	80.06	16.37	348.46	1.55	16.56
Technical universities	156	25.09	190.47	10.62	167.84	6.49	128.96	1.27	35.83
Polytechnics	142	6.11	11.53	9.29	61.74	2.28	22.82	1.20	12.77

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