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Abstract

The viability of modern open science norms and practices depend on public disclosure of new knowledge, methods, and materials. However, increasing industry funding of research can restrict the dissemination of results and materials. We show, through a survey sample of 837 German scientists in life sciences, natural sciences, engineering, and social sciences, that scientists who receive industry funding are twice as likely to deny requests for research inputs as those who do not. Receiving external funding in general does not affect denying others access. Scientists who receive external funding of any kind are, however, 50% more likely to be denied access to research materials by others, but this is not affected by being funded specifically by industry.

Keywords: open science, research funding, industry sponsorship, research inputs
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1. Introduction

Recent decades have seen a shift in academic research towards the ‘entrepreneurial university’ model. Researchers are encouraged to actively participate in innovation through channels such as academic patenting, joint work with industry, or academic entrepreneurship (Etzkowitz, 2003). Besides obvious benefits of technology transfer and increased funding at research institutions through industry collaborations, scholars have expressed concerns that the shift towards entrepreneurial universities may entail negative implications for the rate and direction of academic research. Examples include trade-offs between publishing and patenting (Azoulay et al., 2009), academic entrepreneurship and the ‘brain drain’ in academia (Toole and Czarnitzki, 2010; Aghion et al., 2008), the dissemination of research results (Czarnitzki et al., 2011; Blumenthal et al., 1996a,b; Cohen et al., 1998; Gans and Murray, 2011; Thursby and Thursby, 2007), and the withholding of information, data and materials on which research is based (Walsh et al., 2007; Haeussler, 2011; Haeussler et al., 2014).

This paper seeks to contribute to the latter stream of research. Sharing data and material inputs to research is one of the cornerstones of scientific progress since it allows replication, validation and the cumulative advance of knowledge in a field. Data and research materials are also a major source of scientific misconduct. One prominent case is the South Korean scientist Woo-Suk Hwang and his colleagues who published an article in *Science* in 2005 claiming to have isolated embryonic stem cells from a cloned human embryo (Hwang et al., 2005). Scientists immediately started research to build on these highly exciting findings. However, the published results turned out to be fabricated, and the paper was retracted less than a year later (Azoulay et al., 2012). Another case is the prolific Danish neuroscientist Milena Penkowa who had published almost 100 papers in renowned journals. In January 2011 *Nature* reported that Penkowa had left her position at the University of Copenhagen under allegations of scientific misconduct (including the fabrication of data and misspending of grant money). While Penkowa had been cleared of allegations of scientific fraud in 2008 (colleagues had trouble replicating her results), new allegations arose in 2010: two of Penkowa's students did not manage to replicate data submitted to the Journal of Clinical Oncology by Penkowa (see Callaway, 2011). More generally, Azoulay et al. (2012) find that out of the 1104 retractions identified in 'Pubmed', the US National Library of Medicine, 739 (67%) were due to issues related to data fabrication, data errors or mistakes, failure to replicate results, or plagiarism. This suggests that more open sharing of data and material could serve as a major source of quality control in scientific research.

In this paper, we focus on how extramural and in particular industry funding of academic research affect academics' sharing behavior. Although extramural and particularly industry funding of research are responsible for a growing share of academic research (OECD, Main Science and Technology Indicators, 2010), relatively little attention has been devoted to studying the relationship between funding and sharing behavior. Industry funding has frequently been characterized as posing restrictions on researchers, prohibiting or delaying the open disclosure of research results (Blumenthal et al. 1996a,b; Cohen et al. 1998; Gans and Murray 2011; Thursby and Thursby 2007). This could hamper scientific research, as the public disclosure of research results limits a duplication of research, and facilitates replication and follow-up research (Dasgupta and David 1994).

Our research builds on a broad individual-level dataset of German academics. Germany experienced the largest growth in industry sponsorship of academic research (13.4 percentage points between 1995 and 2007) among developed countries, making it especially suitable for this investigation. Moreover, our data allow us to provide evidence for a broad set of scientific disciplines while prior research is largely confined to the bio sciences which are characterized by all kinds of peculiarities in research conduct and funding compared to other disciplines (e.g., Haeussler, 2011; Haeussler et al., 2014). In the regressions we disentangle total extramural funding received from funding that comes specifically from industry sponsors and find that, controlling for personal characteristics, research characteristics, institutional affiliations, and scientific fields, scientists who receive external funding from any source are more likely to be denied access to others' research results or materials. Those who receive industry funding are more likely to deny others' requests for access. These results reflect the changes in incentives of researchers to disclose as funding moves towards the private sector.

The rest of this paper is organized as follows. The next section summarizes current literature on academics' sharing behavior and the relation between industry sponsorship of academic research and disclosure. Section 3 describes the data and methods. Results and concluding remarks are shown in sections 4 and 5.

2. Literature background

2.1 Input sharing among academics

A few recent studies have looked more in detail into academics' sharing behavior. Walsh et al. (2007) surveyed 507 academic researchers in biomedical sciences to assess what affects access to knowledge and material inputs. Of the scientists surveyed in the two years before the survey 75% requested material and made seven requests on average. Only 81% of the most recent requests were fulfilled. Those receiving the requests reported that they did not fulfill the request in 6% of the cases. Their results indicate that requests to scientists active in business, scientists in fields with higher degrees of competition, and scientists with higher publication outputs were more likely to remain unfulfilled. However, the authors found no significant effect of the requesting scientist's industry funding.

Haussler (2011) reports the likelihood with which scientists in industry and academe share information, using a survey of bioscientists in Germany and the United Kingdom. Academic scientists reported providing 85% of the requested information, while industry researchers reported to have provided 58%. The share of information exchanged further depends negatively on its competitive value, the expected level of reciprocity (positively, but only among industrial researchers), social factors (norms regarding information sharing and entrepreneurs in the scientists' family), the type of enquirer, and the degree to which the requested information is protected by non-disclosure agreements.

Haeussler et al. (2014) hypothesize that information sharing among academics is highly context-specific, arguing that specific requests for information or materials are weighted in terms of future reciprocity versus current loss of competitiveness, while general sharing of intermediate results is affected by the need for feedback versus potential misappropriation. They then employ a survey of 1173 bioscientists in Germany and the United Kingdom to support these claims, showing that specific as well as general sharing are negatively affected by competition in the field and the importance researchers attach to patents for their reputation. Moreover, tenured professors are more likely to engage in specific information sharing. General sharing occurs less often in larger teams and by people who have applied for more patents, but more often for researchers who publish more.

2.2 External sponsorship and disclosure

Several papers have found harmful effects of industry sponsorship on the disclosure of research findings. For instance, Gans and Murray (2011) report, based on data on contract terms offered to industrial sponsors, that the majority of contracts allowed for the restriction and disclosure of information designated as confidential. Blumenthal et al. (1996b) surveyed 210 life science companies to find evidence of publication delays and secrecy restrictions on information resulting from academic research. Thursby and Thursby (2007) surveyed 112 firms engaged in university licensing to find that 90% of the university contracts include clauses on withholding of research results.

Blumenthal et al. published six studies in which they report the results of three life science faculty surveys between 1985 and 2000 (Blumenthal et al. 1986, 1996a, 1997, 2006; Campbell et al. 2000, 2002). These studies find that researchers with industry sponsored projects are more likely to report industry ownership of results, pre-publication review, publication delays, and secrecy. Czarnitzki et al. (2011) employ a survey of German researchers to investigate the relation between industry sponsorship and the disclosure of academic research, in the forms of publication delays and secrecy, finding that scientists with higher degrees of industry sponsorship (i.e. a larger share of their total budget comes from industry sources) have higher probabilities of facing publication delays, or (partial or full) publication bans. The amount of total extramural funding also has a positive effect on withholding research results.

Hong and Walsh (2009) combined two surveys of researchers in experimental biology, mathematics, and physics on how safe they perceived discussing current work with colleagues. In 1966, 49% of the surveyed 1,042 scientists indicate not feeling safe talking with others about their research. By 1998, this increased to 72% (out of 192 scientists surveyed). This increase is strongest in experimental biology where the share of scientists concerned with secrecy has skyrocketed from 55% to 87%. The authors then show that having industry funding relates to higher levels of increased secrecy, as does having stronger scientific competition.

The above overview suggests extramural and particularly industry funding to be related to the likelihood that scientists will share their data and material inputs and to the likelihood that scientists themselves will deny others access to their inputs. In the following, we seek to provide empirical evidence based on a comprehensive sample of German academics in order to elucidate the relationship between funding and sharing behavior.

3. Data and Methods

We use data from an online survey of German academic researchers performed by the Centre for European Economic Research (ZEW) in the context of an evaluation of the EU's 6th European Framework programme. The survey was conducted in 2008. The sample includes German Ph.D. level researchers who were employed at universities or not-for-profit research institutions. To identify university professors, a register ("Hochschullehrerverzeichnis") was employed that excludes teaching-oriented universities in applied sciences. Not-for-profit institutes include the Fraunhofer Society, the Max Planck Society, the Helmholtz Association, and the Leibniz Association. Scientists employed there were identified using internet searches.[1] This yielded a sample frame of 16,269 scientists with known email addresses. 2,797 researchers completed at

[1] These institutes are major actors in German science, and have many branches across disciplines. For example, the Fraunhofer society has 17,000 employees in 59 institutes. The other science organizations are of comparable size. It is common for German university professors to head research groups at these institutes.

least one question in the survey. Removing observations with missing values of interest for the purpose of this study, we end up with a final sample of 837 observations.[2]

We test the representativeness of our sample by comparing it to the population distribution of public research scientists across institutional categories (universities versus PROs) and disciplines obtained from the Federal Statistical Office. The official and sample shares are presented in Table 1. While the sample is reasonably representative of the population, there are some small differences. Our sample has 8% more scientists employed in public research organizations than the population. The sample also contains 5% more life scientists, 2.4% fewer science/humanities researchers, and 1.8% fewer natural scientists than the population. To ensure the robustness of our results, we re-estimated the regression models presented in section 4 adjusting for any bias caused by field or institute sampling through population weights based on eight institute-field strata (see table A.1 in appendix). The results are highly similar to those of the un-weighted sample.

Insert Table 1 about here

The dependent variables are derived from two survey questions regarding the disclosure of research materials to colleagues. The first one asks "Have you requested any research results (such as software, genetic sequences, data), and/or research materials since 2002 from other scientists but did not get access?". Table 2 shows summary statistics. Respondents could check

[2] The large discrepancy here is caused in part by many researchers filling in only few questions. Only 1,400 scientists considered all questions in the survey. As these still had some item non-response, we had to exclude part of the sample.

boxes “yes”, “no”, or “not specified”. 139 respondents, or 17% of the sample, indicated that they had requested results or materials but did not receive them. The second question asked “Have you denied other scientists access to your research results or materials since 2002?”. This was the case for 57 respondents (7%). Of those who were denied or who denied access (169 observations), 112 (66%) were denied access but did not deny it themselves, 30 (18%) only denied access to others, and 27 (16%) did both.

The main explanatory variables are two dummy variables whether the researcher received funding from third-party sources and whether, among the third-party resources, the researcher received funding specifically from industry. Both dummies correspond to the time period 2002-2006. 84% of the researchers reported third-party funding, and 33% reported that they received industry funding. Scientists who received third-party funding were significantly more likely to be denied access to others’ research results or materials (18% of those with funding vs. 10% of those who did not (*t*-test on mean differences = -2.35, *p*-value = 0.02), but not more likely to deny access to others (7% vs. 7%, *t*-test = -0.05, *p*-value=0.96). Scientists who received industry funding were not more likely to be denied access by others (18% vs. 16%, *t*-test = -0.79, *p*-value = 0.43), but were more likely do deny others (12% vs. 4%, *t*-test = -3.86, *p*-value < 0.01).

Insert Table 2 about here

We control in the analysis for research characteristics, personal characteristics, scientific domains, and institutional affiliations. Research characteristics include the individual’s position at the institution, the number of publications and patent applications, and the number of scientists employed at the respondent's institute who work on similar topics. The latter serves as a proxy for the degree of scientific competition of the field, as greater scientific competition associates with higher levels of secrecy (Hong and Walsh, 2009; Haeussler, 2011). Personal characteristics are age, gender, and whether the scientist is tenured. In terms of domains, the researchers were grouped in four broad fields consisting of life sciences, natural sciences, engineering, and social sciences. Institutional affiliations include universities, the four large public research associations (Fraunhofer, Max-Planck, Helmholtz and Leibniz), and a residual group of other affiliations (these include public research institutes which are financed by the states and not the federal government, for instance).[3]

To examine the relation between third-party and industry funding and the disclosure of research results and materials, we specify Probit models. Since the descriptive statistics suggest being denied access and denying access to be related, we also specify a Bivariate Probit model to account for any error term correlation between the equations of being denied access and denying access to others.

4. Results

Table 3 presents the regression results. We first estimate a Probit model for 'Being denied access by others' (column 1). Other factors equal, scientists who received third party funding are more likely to have been denied access to others' research results and materials. The magnitude of the marginal effect is also sizeable: other factors at the mean, the probability of being denied access

3 All these variables have been collected in the survey. In order to check the reliability of the information provided in the survey, we also gathered the publication and patent data from external databases (the ISI Web of Science and the PATSTAT patent database). Although the numbers did not match exactly, the results do not depend on the source of the data (survey vs. publication/patent databases). This test of data reliability makes us confident that also the other variables are quite accurately reported by the scientists. Note that the results reported below are obtained by using the externally collected patent and publication data.

increases from 14% to 21% if the dummy indicating third party funding switches from zero to unit value. Receiving funding specifically from industry and the other research characteristics do not have significant effects. In line with previous studies (e.g. Hong and Walsh 2009), we observe that scientists in the life sciences are more likely to be denied access.

Insert Table 3 about here

Concerning the equation on ‘Denying access’ (column 2), we find no significant effect of third-party funding. This indicates that extramural funding in general, including funding from German or European government organizations, does not hamper the direct dissemination of results and materials to others. However, the coefficient of receiving industry funding is positive and significant. The size of the marginal effect is large: other factors at the mean, receiving industry funding increases the probability of denying access from 5% to 10%. The switch from no industry contracts to having industry funding thus doubles the likelihood of keeping research materials secret.

Column 3 jointly estimates both equations in a Bivariate Probit model taking the correlation between the error terms into account. The error term correlation is positive ($\rho = 0.5$) and significant (LR test on correlation being zero: $\chi^2(1) = 27.18$, p-value < 0.01). We thus conclude that a random shock resulting in being denied access to material also translates into the reaction of denying access to others and vice versa. The results concerning the coefficient estimates model are very similar to the univariate Probit models.

We interpret our findings as follows: the result that researchers who have industry funding are more likely to deny access to research materials might, in line with the literature, reflect clauses in the contracts with industry sponsors that the research has to be kept secret (at least for a certain amount of time) so that the industry sponsor can appropriate possible commercial returns afterwards. In addition, the scientist might realize that she or he possesses a monopoly in a certain domain and that this could not only be profitable for the institution regarding research budgets but also privately profitable, be it either supplemental remuneration by the public research institution for attracting outside funding or other private consulting contracts. Since the result in the 'Deny access' equation is only found for the industry dummy and not for the extramural funding in general, it is plausible to assume that contract clauses imposed by the industry partners are the main reason for not sharing materials. As this strongly contradicts the paradigm of open science the trend towards entrepreneurial universities should not be celebrated for improved technology transfer without caution as, in the extreme, it threatens the trust, credibility (because of impossible replication of results) and the evolution of science, and thus also technological progress in the long-run.

When we consider the results for the likelihood to be denied access to research materials it turns out that industry funding is not of particular importance. Instead we find that scientists with extramural research funding in general are more likely to be denied access. We attribute this finding to the fact that these scientists might conduct research in domains that are more competitive than the topics that are being investigated by people that did not rely on extramural research funding. While funding processes are usually merit-based and highly credentialed scientists are more likely to secure such funding (Grimpe, 2012), our result do not suggest, however, that being denied access or denying access is connected to the scientists' individual research productivity in terms of publications and patents. In that sense, we do not find the two outcomes to be particularly salient for "star" versus "non-star" scientists.

Before we conclude, note that we also re-estimate the models using linear probability models (LPMs) rather than Probit models. While the LPM assumes constant marginal effects over the distribution of the regressors and could produce predictions that are not bound between zero and one, it, unlike the Probit model, does not require the normality assumption which, if violated, could lead to inconsistent coefficient estimates in the Probit model. All the findings reported above were very similarly found using the LPMs and therefore we do not report these in more detail here.

Also note that we tested for heterogeneity of the identified effects across scientific fields. Neither of these tests showed significant differences. This is noteworthy as most existing research focuses on the life sciences. We find that the relationship between extramural/industry funding and the access to research materials does not significantly differ between life sciences, natural sciences, engineering and social sciences. Admittedly, our field definitions are quite broad because of our limited sample size. More research could be devoted to the heterogeneity across fields in order to further investigate this issue.

5. Conclusion

Using a comprehensive and cross-discipline dataset on German academics, we provide evidence that industry sponsorship relates to increased denial of requests for research results and materials while extramural funding in general is related to scientists experiencing denial of access themselves. Hence, our research contributes to the literature in several ways. First, we connect research on academics' sharing behavior with the literature that studies the implications of extramural and particularly industry funding on the disclosure of academic research. In that sense, we complement other research on the relation between industry funding and disclosure, which argues that industry sponsorship can harm the public disclosure of academic research (Czarnitzki et al., 2011; Blumenthal et al. 1986, 1996a, b, 1997, 2006; Campbell et al. 2000, 2002, Hong and Walsh, 2007; Walsh et al. 2007).

Second, prior research has largely focused on university scientists the bio sciences. Our study broadens the results obtained in prior research by considering a more general sample of scientific disciplines and institutions. We show that limited sharing as a result of extramural funding is not only a phenomenon apparent only in the bio sciences but instead a broad problem. This is further illustrated in the regression tables provided in appendix table A.2, where we estimate the probability to deny access to others in and outside of the life sciences. The effect is present in both, even though the marginal effect of industry funding is much higher in the life sciences (industry funding more than quadruples the probability of denying funding to others from 2% to 9% in the life sciences, compared with a doubling from 5% to 10% outside of the life sciences).

An implication of our findings is that scientific institutions may need to consider policies that govern the sharing behavior of scientists in order to assure the opportunity to replicate, validate and cumulatively advance the knowledge in the field. Our results also stress that these policies need to be encompassing in the sense that they do not only pertain to research in the life sciences. Another implication concerns the funding bodies, particularly governments and science foundations, which could more actively promote open science and urge scientists to share their research inputs with others.

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Tables

Table 1 German academic scientist population and sample field distribution

	Population Share Academic Scientists	Sample Share Academic Scientists
Employed in university (vs. PRO)	67.6%	59.6%
Field		
Natural sciences	31.1%	29.3%
Engineering sciences	19.3%	19.6%
Life sciences	25.2%	29.2%
Social sciences and humanities	24.4%	22.0%

Table 2: Summary statistics

Variable	full sample		Was not denied access		Was denied access		Did not deny access		Denied access	
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
Total observations (%)	837 (100%)		698 (83%)		139 (17%)		780 (93%)		57 (7%)	
Research characteristics										
Was denied access	0.166	0.372	0.000	0.000	1.000	0.000	0.144	0.351	0.474	0.504
Denied access to others	0.068	0.252	0.043	0.203	0.194	0.397	0.000	0.000	1.000	0.000
Received third party funding	0.840	0.367	0.827	0.379	0.906	0.292	0.840	0.367	0.842	0.368
Received industry funding	0.331	0.471	0.325	0.469	0.360	0.482	0.314	0.464	0.561	0.501
Research group leader	0.730	0.444	0.722	0.448	0.770	0.422	0.726	0.446	0.789	0.411
Journal publications	35.014	58.483	34.665	58.573	36.770	58.208	35.882	59.741	23.140	35.484
Patent applications	0.802	2.818	0.811	2.869	0.755	2.559	0.754	2.713	1.456	3.969
Number of peers in institute	24.201	48.809	23.244	45.853	29.007	61.519	24.017	49.451	26.719	39.241
Personal characteristics										
Researcher has tenure	0.836	0.370	0.850	0.358	0.770	0.422	0.840	0.367	0.789	0.411
Female dummy	0.146	0.353	0.146	0.353	0.144	0.352	0.145	0.352	0.158	0.368
Age	49.542	8.377	50.200	8.373	46.239	7.608	49.635	8.394	48.264	8.106
Science domains										
Life sciences	0.292	0.455	0.259	0.439	0.453	0.500	0.295	0.456	0.246	0.434
Natural sciences	0.293	0.455	0.315	0.465	0.180	0.385	0.303	0.460	0.158	0.368
Engineering	0.196	0.397	0.193	0.395	0.209	0.408	0.176	0.381	0.474	0.504
Social sciences	0.220	0.414	0.232	0.422	0.158	0.366	0.227	0.419	0.123	0.331
Institutions										
Employed at university	0.596	0.491	0.605	0.489	0.554	0.499	0.606	0.489	0.456	0.503
Employed at Fraunhofer Society	0.049	0.216	0.050	0.218	0.043	0.204	0.042	0.201	0.140	0.350
Employed at Max Planck Society	0.091	0.287	0.092	0.289	0.086	0.282	0.092	0.290	0.070	0.258
Employed at Helmholtz Association	0.154	0.361	0.148	0.355	0.187	0.391	0.147	0.355	0.246	0.434
Employed at Leibniz Association	0.063	0.244	0.054	0.227	0.108	0.311	0.064	0.245	0.053	0.225
Employed at other research institute	0.091	0.287	0.092	0.289	0.086	0.282	0.090	0.286	0.105	0.310

Table 3: Multivariate regression results

	(1)	(2)	(3)	
	Was denied access	Denied access to others	Was denied access	Denied access to others
Received third party funding	0.389**	-0.335	0.375**	-0.297
	(0.182)	(0.225)	(0.181)	(0.221)
Received industry funding	0.056	0.481***	0.043	0.417**
	(0.131)	(0.177)	(0.131)	(0.175)
Female dummy	-0.137	0.195	-0.123	0.222
	(0.162)	(0.204)	(0.159)	(0.198)
Age	-0.086	0.102	-0.079	0.115
	(0.074)	(0.096)	(0.075)	(0.097)
Age squared	0.001	-0.001	0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Researcher has tenure	-0.041	-0.391*	-0.044	-0.342
	(0.177)	(0.228)	(0.176)	(0.227)
Research group leader	0.185	0.355*	0.174	0.344*
	(0.141)	(0.193)	(0.141)	(0.191)
Journal publications	0.001	-0.003	0.001	-0.003
	(0.001)	(0.002)	(0.001)	(0.002)
Patent applications	-0.004	0.012	-0.006	0.010
	(0.021)	(0.022)	(0.022)	(0.023)
Number of peers in institute	0.001	-0.001	0.001	-0.001
	(0.001)	(0.002)	(0.001)	(0.002)
Domain: life sciences	0.470***	0.161	0.482***	0.194
	(0.167)	(0.241)	(0.167)	(0.241)
Domain: natural sciences	-0.262	-0.114	-0.235	-0.103
	(0.184)	(0.260)	(0.184)	(0.259)
Domain: engineering	0.223	0.661***	0.217	0.671***
	(0.191)	(0.238)	(0.191)	(0.239)
Employed at Fraunhofer Society	-0.194	0.478*	-0.147	0.501*
	(0.292)	(0.278)	(0.287)	(0.275)
Employed at Max Planck Society	0.018	0.329	-0.009	0.317
	(0.213)	(0.297)	(0.215)	(0.294)
Employed at Helmholtz Association	0.323*	0.601***	0.314*	0.614***
	(0.174)	(0.218)	(0.172)	(0.216)
Employed at Leibniz Association	0.680***	0.397	0.662***	0.333
	(0.213)	(0.320)	(0.214)	(0.324)
Employed at other research institute	0.012	0.209	-0.020	0.130
	(0.198)	(0.255)	(0.202)	(0.264)
Intercept	1.370	-4.183*	1.218	-4.559*
	(1.770)	(2.333)	(1.784)	(2.349)
Corr ($\varepsilon_1, \varepsilon_2$)			0.501***	
# Observations	837	837	837	
Log-Likelihood	-338.11	-181.63	-506.16	

Notes: Standard errors in parentheses. *(,**,***): $p < 0.1$($p < 0.05$, $p < 0.01$).
Columns (1), (2): Probit models; (3): Bivariate Probit models.
Reference categories for the dummy variables: male, non group leader, untenured, social scientist, employed at a university.

Appendix

Table A.1 weighted regression results using eight institution-discipline strata

	(1)	(2)	(3)	
	Was denied access	Denied access to others	Was denied access	Was denied access
Received third party funding	0.378**	-0.352*	0.365**	-0.309
	(0.184)	(0.211)	(0.184)	(0.214)
Received industry funding	0.049	0.458**	0.036	0.397**
	(0.133)	(0.180)	(0.132)	(0.180)
Female dummy	-0.135	0.227	-0.117	0.246
	(0.167)	(0.212)	(0.164)	(0.210)
Age	-0.077	0.119	-0.070	0.133
	(0.075)	(0.091)	(0.076)	(0.089)
Age squared	0.000	-0.001	0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Researcher has tenure	-0.013	-0.485**	-0.017	-0.440*
	(0.176)	(0.230)	(0.175)	(0.228)
Research group leader	0.146	0.381**	0.134	0.371**
	(0.139)	(0.170)	(0.140)	(0.173)
Journal publications	0.001	-0.003	0.001	-0.003
	(0.001)	(0.002)	(0.001)	(0.002)
Patent applications	-0.002	0.016	-0.005	0.015
	(0.020)	(0.019)	(0.021)	(0.019)
Number of peers in institute	-0.000	-0.001	-0.001	-0.001
	(0.001)	(0.002)	(0.001)	(0.001)
Domain: life sciences	0.471***	0.042	0.483***	0.082
	(0.167)	(0.248)	(0.167)	(0.244)
Domain: natural sciences	-0.286	-0.110	-0.258	-0.095
	(0.187)	(0.260)	(0.185)	(0.257)
Domain: engineering	0.208	0.654***	0.203	0.664***
	(0.195)	(0.253)	(0.194)	(0.250)
Employed at Fraunhofer Society	-0.239	0.482	-0.190	0.504*
	(0.273)	(0.297)	(0.268)	(0.292)
Employed at Max Planck Society	-0.026	0.160	-0.058	0.129
	(0.230)	(0.303)	(0.234)	(0.293)
Employed at Helmholtz Association	0.406**	0.601***	0.396**	0.625***
	(0.180)	(0.222)	(0.178)	(0.223)
Employed at Leibniz Association	0.642***	0.278	0.623***	0.219
	(0.222)	(0.333)	(0.223)	(0.317)
Employed at other research institute	0.077	0.237	0.048	0.160
	(0.207)	(0.247)	(0.214)	(0.244)
Intercept	1.212	-4.600**	1.047	-4.994**
	(1.813)	(2.276)	(1.836)	(2.228)
Corr ($\varepsilon_1, \varepsilon_2$)			0.585***	
# Observations	837	837	837	
Log-Likelihood	-328.261	-169.045	-135922.9	

Notes: Standard errors in parentheses. *(,**,***): $p < 0.1$ ($p < 0.05$, $p < 0.01$).
Columns (1), (2): Probit models; (3): Bivariate Probit models.
Reference categories for the dummy variables: male, non group leader, untenured, social scientist, employed at a university.

Table A.2: Denying access to others: life sciences versus other fields

	(1) In life sciences	(2) Outside life sciences
Received third party funding	-0.844	-0.367
	(0.514)	(0.279)
Received industry funding	0.988**	0.504**
	(0.453)	(0.210)
Female dummy	0.669*	0.034
	(0.385)	(0.273)
Age	0.019	0.157
	(0.272)	(0.111)
Age squared	-0.001	-0.002
	(0.003)	(0.001)
Researcher has tenure	-0.048	-0.483*
	(0.476)	(0.280)
Research group leader	0.682	0.320
	(0.502)	(0.224)
Journal publications	-0.005	-0.001
	(0.004)	(0.002)
Patent applications	-0.178	0.017
	(0.204)	(0.023)
Number of peers in institute	0.003	-0.003
	(0.003)	(0.003)
Domain: natural sciences		-0.137
		(0.274)
Domain: engineering		0.569**
		(0.246)
Employed at Fraunhofer Society	0.398	0.508
	(0.829)	(0.309)
Employed at Max Planck Society	1.087**	-0.133
	(0.520)	(0.484)
Employed at Helmholtz Association	0.700	0.662**
	(0.464)	(0.265)
Employed at Leibniz Association	1.431**	-0.021
	(0.581)	(0.479)
Employed at other research institute	0.140	0.316
	(0.598)	(0.299)
Intercept	-1.610	-5.504**
	(6.231)	(2.723)
# Observations	244	593
Log-Likelihood	-42.075	-131.009

Notes: Dependent variable: denied access to others. Standard errors in parentheses. *(,**,***): $p < 0.1$ ($p < 0.05$, $p < 0.01$). Probit models. Reference categories for the dummy variables: male, non group leader, untenured, employed at a university. Column 2: reference field: social scientist..

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