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Participation of Academic Scientists in Relationships with Industry

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Abstract

Relationships between academic researchers and industry have received considerable attention in the last 20 years, but current data on the prevalence, magnitude, and trends in such relationships are rare. In a mailed survey of 3080 academic life science researchers conducted in 2007, we found the majority (52.8%) of academic life scientists have some form of relationship with industry. Compared to our previous studies in 1995 and 1985, we found a significant decrease in industry support of university research, which could have major consequences for the academic life science research sector.

The advent of biotechnology,[1] the Bayh-Dole Act[2] and judicial decisions in the 1980's regarding the patentability of life science research results accelerated relationships between academic scientists and industry.[3] These relationships can take many forms including, consulting, holding equity ownership, serving on advisory boards, and being a paid speaker for a company. The most traditional form of industry relationship is research grants and contracts.[4]

Prior studies suggest that industry funding of university-based research has contributed to the transfer of technology from the academic to the industrial setting.[5] However, these relationships can have other unintended consequences including increased secrecy [6], growing emphasis on commercializable research, and possible reporting bias [7] and other negative results.[8]

The benefits, risks and institutional responses suggest there is value in studying the continued evolution of these relationships. The most representative national data on industry relationships was collected more than a decade ago; meanwhile, much has changed. Universities, professional associations, journals and governmental agencies have adopted extensive policies to manage and mitigate these unintended effects.[9] The budget of the National Institutes of Health doubled between 1998 and 2003.[10,11] Non-academic contract research organizations gained substantial market share as an alternative to academic settings for conducting clinical research.[12] Furthermore, the pharmaceutical industry began to experience economic problems resulting from a growth in drug development costs, a decrease in new product introductions, and a reduction in patent exclusivity.[13] These developments may have important potential consequences for academic industry relationships (AIRs).

To assess industry relationships among academic scientists, we conducted a national survey of life science faculty concerning their involvement with industry. This study is the third in a series of data collections, the first two which were fielded in 1985 and 1995 regarding the frequency of industry funded research support in the form of a grant or contract.[14] Together, these surveys provide the only representative, national, longitudinal data on industry research funding between life scientists and commercial organizations in the United States.[14]

METHODS

Sample Selection

The data presented here were collected from a survey of life science faculty conducted between December 2006 and March 2007. A sample of 3080 faculty members was selected in a three-step process similar to that used in previous studies.[15] First, we identified the 50 U.S. universities that received the most extramural research support from the National Institutes of Health in 2004. Second, within these institutions, we identified all life-science departments and programs in four survey strata: departments of medicine, other clinical departments (non-medicine), non-clinical life science departments, and genetics departments or programs.[16]

Third, we selected a stratified, random sample of life-science faculty members in each of the four sample strata. Names and addresses were drawn from departmental websites and from the Association of American Medical Colleges (AAMC) Faculty Roster (for the clinical strata). To avoid the inclusion of fellows and hospital staff members not truly functioning as clinician-researchers, clinical faculty members were eligible for the sample only if they had a publication other than a review or a letter listed in the National Library of Medicine’s Medline database for the period from 2003 through 2005.

Survey Design, Administration, and Response Rates

The survey instrument was a modified version of an instrument administered in 1985 and in 1995.[17] New items were developed using 2 focus groups and 10 confidential personal interviews of scientists, and was pretested using 11 cognitive interviews. The survey was conducted by mail by the Center for Survey Research at the University of Massachusetts.

Of the 3080 faculty researchers in our sample, 139 were ineligible because they were deceased, retired, did not hold a faculty appointment, or could not be located (no return address provided on undelivered questionnaires and unsuccessful telephone follow-up). Of the remaining 2941 faculty members, 2168 completed the survey, for an overall response rate of 74%; 1071 (72%) of the respondents were from clinical departments, and 1097 (75%), were from nonclinical departments.

Statistical Analysis

Two variables were created to measure different aspects of publication: publication trends and journal impact factor. The publication-trends variable for a researcher was the difference between the number of his or her peer-reviewed articles published in the previous three years and the average number of peer-reviewed articles published per three-year period over his or her entire academic career, excluding the most recent three years. To estimate the average influence of a researcher's publications, we asked respondents for the names of the journals in which their last five peer-reviewed articles had appeared. Journal impact factors were derived from the 2006 ISI Web of Science[18] and an average was calculated for each respondent.

The data were analyzed using standard statistical techniques. To be comparable with our previous work, the data were analyzed in groups of clinical faculty (consisting of clinical/medicine and clinical/non-medicine departments) and nonclinical faculty (consisting of genetics and other life science departments), each weighted by the inverse probability of selection and differential non-response.[19] Unless otherwise noted, statistical significance was tested using multivariate linear and logistic regressions adjusting for professional age, sex, academic rank, clinical or nonclinical department, and total research budget (log of direct costs) from all sources.

RESULTS

Characteristics of Respondents

Table 1 shows the unweighted characteristics of respondents by survey strata. Of the respondents, 72% were male and 80% were white. In terms of academic rank 45% were full professors, 26% associate professors and 26% assistant professors. Clinical respondents were significantly less likely than non-clinical to be full professors (34% v.55%, $p<0.01$).

Prevalence and Magnitude of Academic-Industry Relationships Generally

Table 2 shows the prevalence of many types of academic-industry relationships (AIRs). Over half of all researchers (52.8%) had some type of relationships in the past three years with industry. The most common types of industry relationships involved consulting (31.8%), paid-speaking (23.8%), receiving research funding through a grant or contract as the principal investigator (20.1%), and sitting on a scientific advisory board (17.7%). Compared to clinical departments, those in nonclinical departments were more likely to be involved with industry in the early stages of product development, through the licensing of intellectual property (17.0% vs. 7.4%, $p< 0.001$) and the founding and management of companies (6.4% vs. 4.1%, $p=.02$).

The frequency of the various types of academic-industry relationships was strongly associated with faculty rank, where nearly two-thirds (64.2%) of full professors maintained some form of relationship with industry, compared to 51.5% of associate professors and 42.8% of assistant professors ($p<0.001$). This pattern is consistent across many of the specific types of relationships, where full professors were sometimes twice as likely to be involved with industry as more junior faculty.

A significantly greater proportion of those in clinical departments (23.3%) than in non-clinical departments (9.4%) reported receiving industrial research funds ($p < 0.001$). Overall, industry supplied an average of $33,477 in research funds excluding overhead per respondent, representing 8.7% of all the research funds received by faculty (data not shown in table). Industrial funds constituted a significantly greater proportion of overall research support for clinical faculty members than for non-clinical faculty members (10.5% vs. 2.5%, p< 0.001). Within the subset of those receiving industrial funds, this support represented 45.0% of all research funding and was significantly higher within clinical departments than in nonclinical departments (47.3 % vs. 26.3%, p< 0.001). When we asked, “To what extent had involvement with industry contributed to their most important scientific work?” 13.1% of these faculty responded to a “great extent” while another 46.0% responded to “some extent.”

Industry Relationships and Academic Activities of Faculty Members

Table 3 shows the respondents’ participation in several academic activities and their industry relationships, after controlling for differences in academic rank, department, tenure, gender, and total funding. On all measures, faculty with industry relationships published significantly more and published at greater rate in the last three years than respondents without such connections. The average journal impact factor of the most recent five articles by respondents with at least one AIR was also significantly higher than for those without any type of industry relationship.

Researchers with at least one industry relationship conducted more service activities in their institutions or disciplines than respondents without relationships (2.0 vs. 1.2 activities, p< 0.001). Academics with industrial relationships spent more hours per week performing outside professional activities such as giving external lectures, working with professional societies and advisory groups, and the associated travel with these activities (4.4 vs. 2.8 hours, p<0.001).

We examined the relationship between the level of industrial research support (defined as the proportion of the faculty member’s total direct research budget) and participation in academic activities. The total number of publications, rates of publication in the previous three years, and the numbers of service activities were highest for faculty members with modest support from industry (one third or less of their total research budget) and tended to decline as the proportion of research funds from industry increased. The number of hours per week dedicated to research was highest among respondents with modest research support from industry (1–33% of funding) and lowest for respondents with more than two-thirds of their funding from industry.

Restrictions on Communication and Choice of Research and Industry Research Support

As shown in Table 4, 12.6% of faculty members with industrial support and 7.4% of those without reported that trade secrets had resulted from their research in 2006 (p< 0.001). Trade secrets were defined as information kept secret to protect its proprietary value. Faculty members with industrial support were also significantly more likely to report that their choice of research topics had been affected somewhat or greatly by the likelihood that the results would have a commercial application (27.3% vs. 14.8 %, p< 0.001). In addition, those with industrial support were more likely to report that a publication was delayed by six months or more (13.4% vs. 6.1%, p<0.001) or specifically to delay the dissemination of undesired results (5.0% vs. 1.1%, p<0.001).

Changes in the Extent and Effects of Industrial Research Support over the Past Two Decades

To understand how industry-sponsored research has changed over time, we compared the results of this study with those of similar surveys we conducted in 1985 and 1995.[20] The 1995 and 2007 samples included faculty members in all life sciences and thus were broader than the sample in our 1985 study, which focused only on investigators in nonclinical departments who were working with then termed the “new biotechnologies”: recombinant DNA, monoclonal antibodies, gene synthesis, gene sequencing, cell and tissue culture, enzymology, and large-scale fermentation. Therefore, in comparing the results of these three studies, we used data provided by the subset of 1,103 respondents in 2007 and 561 respondents in the 1995 survey who reported using biotechnology techniques in their research.

Table 4 shows the trends in the percentage of researchers with industry funding. In 1985, 23% of faculty members using biotechnology tools reported that they were principal investigators on research projects funded by industry, as compared with 21% in 1995 ($p = 0.34$) and 17% in 2007 ($p<.001$). For these faculty members, industry supplied 7.4% of their total research budgets in 1985, as compared with 5.8% in 1995, and 6.1% in 2007. However, use of these techniques has grown exponentially over the decades and is used by a wide variety of scientists; these techniques are now employed by many clinical researchers, making direct comparisons difficult.

More analogous are the comparisons of all research faculty from 1995 and 2006. Overall, the proportion of faculty with industrial funding dropped from 28% to 20% ($p<0.001$). Among those in clinical departments the percentage decreased from 36% in 1996 to 23% in 2007 ($p<0.001$); a similar decrease occurred among those in nonclinical departments (21% in 1996 vs. 9% in 2007, $p<0.001$, data not shown). Of the faculty with industrial support, the median amount of industrial funding in 2006 was $99,000, which represented a similar (CPI-medical adjusted) value of $91,500 in 1996.

In examining the trends in academic activities, Table 4 shows that the direction and significance of the differences between faculty with and without industrial support were generally similar across the three time periods, while the magnitude of the difference in publications appeared to be increasing. In contrast, differences in the patenting of faculty with and without industrial support diminished. When respondents were asked about trade secrets and whether the choice of research topics had been influenced by the commercial potential of the results, the differences between faculty with and without industrial support were no longer significant in the 2007 study.

Discussion

This study provides the most current, national data on the extent of various industry relationships among academic scientists. Overall our data demonstrate that more than half of all academic life scientists had at least one form of direct industry relationship in the last 3 years, principally serving as consultants, paid speakers, and scientific advisory board members.

There are many potential impacts of these data. First, given that industry relationships are frequent and diverse, close scrutiny of researcher’s industry relationships is likely to be a significant undertaking for institutions—especially among those with large numbers of researchers. Second, relationships are most common among productive, senior faculty members who contribute substantially to their research community. This finding supports the belief that it is difficult, but not impossible, to find academic scientists without industry relationships to serve in advisory roles for organizations like the Food and Drug Administration, the National Institutes of Health or the Institute of Medicine. Third, the widespread nature of these relationships will raise serious concerns regarding the integrity of the academic research enterprise (either rightly or wrongly) on the part of elected officials, university officials and perhaps the American public.

Compared to our previous research, this study suggests patterns of change. The principal change is a significant reduction in the proportion of faculty receiving research support from industry. The causes of this drop are multi-facetted. Investigator dependence on industry may have been reduced due to the doubling of NIH funding and the rise of university policies that may have impeded academic-industry relationships. On the other hand, companies may be reducing their spending on academic research. The National Science Foundation suggests that industry's share of financial support for academic research and development in all fields peaked at 7% in 1999 and decreased to its current level of 5% in 2003.[21] Moreover, industry is embracing globalization as evident through the rapid movement of clinical trials overseas to less wealthy countries.[22] Additional research is needed to more fully understand the long-term significance decreases in industry sponsored research.

Our data suggest patterns of constancy as well. In 2007, as in previous surveys, we found that life science faculty with industry research support were more productive on virtually every measure of commercial and academic activities we employed. Given the cross sectional nature of the study these findings do not prove a causal relationship between industry funding and faculty productivity. While industry relationships may provide resources which increase faculty activities, it is also likely that industry selects the most productive university life scientists to support – often well-published, connected, full professors. For example, the current differences in patent rates between industry-sponsored research faculty and their peers disappears after adjusting for academic rank ($p=.154$).

The data also indicate that faculty with modest levels of support (<33%) outperform colleagues with greater proportions of industry funding. Part of this relationship likely stems from the researcher and type of research being conducted. For example, faculty with substantial industry funding (67–100%) are predominantly clinicians who are solely working on industry-sponsored clinical trials. Because they spend significantly more time on patient care duties and less time on research tasks (Table 3), they have less time to publish or provide professional service.

Concurrently, some potentially adverse associations with industry funding continue. As in the past, faculty with industry support in 2006–2007 were significantly more likely to report that trade secrets resulted from their work and that they experienced prolonged (greater than six months) delays in publication. These findings suggest that data withholding remains a greater (though perhaps diminishing) problem for industry funded scientists and that university authorities need to remain vigilant that such funding may increase levels of secrecy on their campuses. This is especially true among faculty without industry funding, where rates of trade secrecy have more than doubled from 3% in 1985 to 7.3% in 2006–2007. These findings also point to the possibility that behaviors previously associated with industry funding are now more widespread among academic scientists without industry support. Consequently, secrecy may be a larger problem in the future as corporate behaviors become more prevalent in academic science, especially among those with industry funding.

Like all surveys, our study has several limitations associated with potential biases of self-reported responses. To the extent that respondents underreport behavior that they consider confidential or socially undesirable, such violating conflict-of-interest policies, our results will underestimate both the potential commercial benefits and the potential risks of academic-industrial research relationships. Further, faculty members who did not respond to our survey may differ systematically from those who did, although we detected no significant differences by known characteristics of our eligible respondents (academic rank, employment within a medical school, or level of institutional NIH funding). Since faculty respondents were included only if they had published a research article in the past three years, the sample population may under-represent new or young researchers.

Now an established feature of the life sciences in the U.S., academic-industry relationships have persisted and evolved over the last twenty years. Industry relationships are now the norm in academic science, given that more than half of academic scientists engage in these activities. Thus, medical schools and teaching hospitals need to pay close attention to the disclosure and management of these relationships. Our data continue to suggest that industry relationships are associated with a complex blend of potential benefits and risks. To the extent that such research relationships speed the translation of fundamental investigation into useful application, engaging the nation's most energetic life science faculty fulfills the public's purposes in supporting biomedical research. To the extent that industry-funded research creates risks for the academic enterprise, the involvement of the most productive faculty enhances those risks, and emphasizes the continued importance of managing these for the purpose of sustaining their benefits while minimizing adverse effects.

References

1. Kenney, M. Biotechnology: The University-Industry Complex. New Haven, CT: Yale University Press; 1988.
2. See Bayh Dole Act, P.L. 96–517.
3. See Diamond v. Chakrabarty, 477 U.S. 303 (1980).
4. In addition to research funding, other types of academic industry relationships exist within academic settings, ranging from gifts for physicians to contracts with the institution. These types of relationships are not included in this paper. See Campbell EG, et al. Institutional Academic Industry Relationships: Results of a National Survey of Department Chairs. Journal of the American Medical Association. 2007; 298(15):1779–1786. [PubMed: 17940234] and Campbell EG, et al. Physician Industry Relationships: Results of a National Survey. New England Journal of Medicine. 2007; 356(17):1742–1750. [PubMed: 17460228]
5. Thursby JG, Thursby MC. Who is Selling the Ivory Tower? Sources of Growth in University Licensing. Management Science. 2002; 48(1):90–104.Bozeman B. Technology Transfer and Public Policy: A Review of Research and Theory. Research Policy. 2000; 29(4–5):627–655.and Blumenthal D, et al. University-industry Relationships in Biotechnology: Implications for the University. Science. 1986; 232(4756):1361–1366. [PubMed: 3715452] For current figures, see Association of University Technology, Inc. AUTM US Licensing Activity Survey: FY 2007. 2008accessed 15 June 2008http://www.autm.net/AM/Template.cfm?Section=Surveys
6. Campbell EG, et al. Data-withholding in Academic Genetics: Evidence from a National Survey. Journal of the American Medical Association. 2002; 284(4):473–481. [PubMed: 11798369]
7. Bekelman JE, Li Y, Gross CP. Scope and Impact of Financial Conflicts of Interest in Biomedical Research: A Systematic Review. Journal of the American Medical Association. 2003; 289(4):454–465. [PubMed: 12533125]
8. Bok, D. Universities in the Market Place: The Commercialization of Higher Education. Princeton, NJ: Princeton University Press; 2000. Krimsky, S. Science in the Private Interest: Has the Lure of Profits Corrupted Biomedical Research?. Lanham, MD: Rowman-Littlefield Publishing Co; 2003.
9. McCrary SV, et al. A National Survey of Policies on Disclosure of Conflicts of Interest in Biomedical Research. New England Journal of Medicine. 2000; 343(22):1621–1626. [PubMed: 11096171] Cho M, et al. Policies on Faculty Conflicts of Interest at US Universities. Journal of the American Medical Association. 2000; 284(17):2203–2208. [PubMed: 11056591] National Institutes of Health. Press Release. Feb 1. 2005 NIH Announces Sweeping Ethics Reform.
10. American Association for the Advancement of Sciene. [accessed 15 June 2008] AAAS Report XXX: Research and Development FY 2006. Chapter 8. 2005. http://www.aaas.org/spp/rd/06pch8.htm
11. Trapp D. Researchers Decry Flat NIH Budgets, Fear Delays in Treatment Advances. American Medical News. Apr 9.2007
12. Shuchman M. Commercializing Clinical Trials - Risks and Benefits of the CRO Boom. New England Journal of Medicine. 2007; 357(14):1365–1368. [PubMed: 17914036]

13. Grabowski H. Are the Economics of Pharmaceutical Research and Development Changing? Productivity, Patents and Political Pressures. Pharmacoeconomics. 2004; 22(2 Supp):s15–s24.
14. Blumenthal D, et al. University-industry Relationships in Biotechnology: Implications for the University. Science. 1986; 232(4756):1361–66. [PubMed: 3715452] and Blumenthal D, et al. Participation of Life-Science Faculty in Research Relationships with Industry. New England Journal of Medicine. 1996; 335(23):1734–1739. [PubMed: 8929266]
15. Ibid.
16. The set of other clinical and nonclinical departments included those receiving the most NIH funding in 2003: Anesthesiology, Neurology, Neurosurgery, Obstetrics/Gynecology, Otolaryngology, Pathology, Pediatrics, Psychiatry, Radiation/Oncology, and Surgery. The nonclinical category consisted of medical school departments and graduate academic programs in Anatomy/Cell Biology, Biochemistry, Microbiology, Pharmacology, and Physiology/Biophysics.
17. Blumenthal, "University."
18. Garfield, E. [accessed 25 July 2007] Thomson Scientific Impact Factor. Jun 20. 2004 http://scientific.thomson.com/free/essays/journalcitationreports/impactfactor/
19. Blumenthal, "University."
20. Ibid.
21. National Science Board. [accessed 4 January 2009] Science and Engineering Indicators 2008. Chapter 5: Academic Research and Development. 2008. http://www.nsf.gov/statistics/seind08/
22. Glickman SW, et al. Ethical and Scientific Implications of the Globalization of Clinical Research. New England Journal of Medicine. 2009; 360(8):816–23. [PubMed: 19228627]

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EXHIBIT 1

Characteristics Of Respondents, Survey Of Academic Researchers Regarding Academic-Industry Relationships, 2006

	All faculty (N = 2.168)		Clinical faculty[a] (n= 1,071)		Nonclinical faculty[b] (n = 1,097)	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Male	1,549	72	729	69	820	76
Race/ethnicity						
Asian	314	15	155	15	159	15
Black or African American	22	1	13	1	9	1
White	1,705	80	832	79	873	81
Other	47	2	24	2	23	2
Declined to report	57	3	31	3	26	2
Hispanic, any race	56	3	29	3	27	3
Years in profession						
0–5	32	1	22	2	10	1
6–10	235	11	126	12	109	10
11–20	685	32	363	34	322	30
21–30	675	32	322	30	353	33
31–40	370	17	164	15	206	19
41+	142	7	62	6	80	7
Academic rank						
Professor	962	45	363	34	599	55[c]
Associate professor	563	28	302	28	261	24
Assistant professor	561	26	339	32	222	20
Other	63	3	59	6	4	1

SOURCE: Authors' analysis of the 2006 Academic-Industry Relationships Faculty Survey.

[a]Defined by employment within a department of medicine, anesthesiology, neurology, neurosurgery, obstetrics/gynecology, otolaryngology, pathology, pediatrics, psychiatry, radiation/oncology, or surgery.

[b]Defined by their employment within a department of anatomy/cell biology, biochemistry, microbiology, pharmacology, or physiology/biophysics, or within a department or doctoral-level degree program in genetics.

[c] $p<0.01$, chi-square comparing clinical to nonclinical faculty.

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EXHIBIT 2

Prevalence Of Academic-Industry Relationships

		Department type		Rank			
	All respondents	Clinical	Nonclinical	Professor	Associate professor	Assistant professor	Other
Any relationship	52.8%	54.7%	45.9%[a]	64.2%[b]	51.5%	42.8%	30.6%
Founder, board of directors, or officer/executive	4.6	4.1	6.4[a]	7.5[b]	3.6	2.5	0.0
Employee	1.5	1.7	0.9	0.6[b]	1.2	2.6	5.2
Scientific advisory board	17.7	18.8	13.7[a]	27.9[b]	14.8	8.5	4.3
Consultant	31.8	33.1	26.9[a]	44.4[b]	29.7	19.2	20.1
Paid speaker	23.8	25.7	16.8[a]	28.3[b]	23.9	18.6	14.8
Recipient of funding for research as a principal investigator	20.1	23.3	9.4[a]	25.6[b]	19.9	13.8	3.3
Recipient of funding for students, post-doctoral fellow	5.9	6.3	4.4	6.4	6.5	5.5	1.5
Sold/licensed patent or recipient of royalties	9.4	7.4	17.0[a]	15.7[b]	6.8	4.5	1.5

SOURCE: Authors' analysis of the 2006 Academic-Industry Relationships Faculty Survey.

NOTES: We asked, "In the past three years, have you served in any of the following roles for companies whose activities, products, or services are in your area of professional expertise: Company founder, Member of the board of directors, Consultant, Employee. Recipient of funding for university research. Recipient of funding for students or post-doctoral fellows, Officer/Executive, Member of scientific advisory board, Recipient of royalties, Company owns or licenses a patent based on your research, or Paid speaker." The response categories were Yes and No.

[a] $p < 0.05$ for the comparison with clinical departments.

[b] $p < 0.05$ from chi-square comparing across rank for all academic-industry relationship comparisons.

EXHIBIT 3

Academic-Industry Relationships And Selected Measures Of Academic Output, 2006

	No. of publications[a]	Publication- trends score[b]	Journal impact factor[c]	No. of service activities[d]
All respondents	10.5 (±0.13)	3.2 (±0.04)	6.0 (±0.02)	1.6 (±0.03)
Any relationship				
No	7.4 (±0.16)	2.0 (±0.05)	5.7 (±0.04)	1.2 (±0.04)
Yes	13.7 (±0.16)[e]	4.3 (±0.04)[e]	6.4 (±0.03)[e]	2.0 (±0.03)[e]
Consultant				
No	8.5 (±0.13)	2.5 (±0.04)	5.8 (±0.03)	1.3 (±0.03)
Yes	14.8 (±0.19)[e]	4.8 (±0.05)[e]	6.5 (±0.04)[e]	2.2 (±0.04)[e]
Paid speaker				
No	9.3 (±0.14)	2.7 (+0.04)	6.0 (±0.03)	1.5 (±0.03)
Yes	14.1 (±0.25)[e]	4.9 (±0.06)[e]	6.2 (±0.05)	2.0 (±0.05)[e]
Scientific advisory board				
No	9.0 (±0.12)	2.7 (+0.03)	5.9 (±0.03)	1.4 (±0.03)
Yes	17.5 (±0.24)[e]	5.6(±0.06)[e]	6.9 (±0.05)[e]	2.5 (±0.05)[e]
Amount of independent support (percent of research budget)				
None	9.9 (±0.14)[f]	2.9 (±0.04)	5.9 (±0.03)	1.6 (±0.03)
1–33	19.6 (±0.37)[f]	7.9 (±0.08)[f]	7.1 (±0.05)	2.7 (±0.07}[f]
34–66	14.1 (±0.51)[f]	3.1 (±0.10)	6.4 (±0.05)	1.6 (±0.11)
67–100	10.3 (±0.48)[f]	3.1 (±0.10)	5.9 (±0.05)	1.7 (±0.10)

SOURCE: Authors' analysis of the 2006 Academic-Industry Relationships Faculty Survey.

NOTES: Mean, adjusted by multivariate analysis of variance to control for differences due to academic ranks, years in profession, sex, total research funding, or clinical department. Standard errors are in parentheses.

[a]We asked, "Approximately how many of articles have you published in refereed journals in the past three years?"

[b]Calculated as the difference between the number of publications in refereed journals during the previous three years and the number of publications in an average three-year period during the faculty member's career; see details in text.

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[c] Calculated as the average journal impact factor of a faculty member's most recent five publications; see details in text.

[d] Number of university or professional activities (in university administration, professional journals, or professional associations).

[e] $p < 0.05$ for the comparison with the subgroup with no relationship.

[f] $p < 0.05$ for the comparison with all other subgroups receiving different levels of industry support.

EXHIBIT 4

Academic-Industry Relationships And Selected Work Activities, 2006

	Teaching hours per week[a]	Research hours per week[b]	Patient care hours per week[c]	Admin. hours per week[d]	Hours of prof. activities per week[e]
All respondents	8.0 (±0.04)	24.1 (±0.17)	16.9 (±0.17)	8.3 (±0.07)	3.6 (±0.04)
Any relationship					
No	8.3 (±0.06)	24.0 (±0.22)	16.7 (±0.15)	7.7 (±0.11)	2.8 (±0.04)
Yes	7.8 (±0.04)	24.1 (±0.17)	17.1(±0.12)	8.8 (±0.09)	4.4 (±0.04)[f]
Consultant					
No	8.5 (±0.05)	24.0 (±0.17)	16.9 (±0.12)	7.9 (±0.09)	3.1 (±0.04)
Yes	7.1 (±0.05)[f]	24.1 (±0.22)	17.0 (±0.15)	9.0 (±0.12}	5.8 (±0.05)[f]
Paid speaker					
No	8.0 (±0.04)	24.7 (±0.15)	15.6 (±0.11)	8.3 (±0.08)	3.2 (±0.04)
Yes	7.9 (±0.06)	22.0 (±0.27)[f]	20.6 (±0.18)[f]	8.3 (±0.15)	4.8 (±0.06)[f]
Scientific advisory board					
No	8.2 (±0.04)	23.6 (±0.14)	17.2 (±0.10)	7.9 (±0.08)	3.2 (±0.03)
Yes	7.3 (±0.06)	26.1 (±0.27)[f]	15.5 (±0.18)	10.7 (±0.14)	5.5 (±0.06)[f]
Amount of independent support (percent of research budget)					
None	8.0 (±0.04)	25.3 (±0.19)	15.0 (±0.18)	8.5 (±0.08)	3.5 (±0.04)
1–33	6.8 (±0.09)	31.8 (±0.29)[g]	11.9 (±0.24)	9.1 (±0.18)	5.2 (±0.08)[g]
34–66	6.5 (±0.10)	24.9 (±0.40)	16.9 (±0.25)	7.4 (±0.29)	23.4 (±0.13)
67–100	8.2 (±0.10)	16.4 (±0.36)[g]	27.6 (±0.34)[g]	7.1 (±0.27)	4.4 (±0.11)

SOURCE: Authors' analysis of the 2006 Academic-Industry Relationships Faculty Survey.

NOTES: Adjusted by multivariate analysis of variance to control for differences due to academic ranks, years in profession, sex, total research funding, or clinical department Standard errors are in parentheses.

[a] We asked, "About how much time do you spend in a typical work week in all teaching activities at your institution: include your instruction of students, residents, interns and fellows, in all clinical, laboratory, and classroom settings."

[b] We asked, "About how much time do you spend in a typical workweek in all research activities at your institution: include all time spent writing proposals, papers, and reports, time spent planning and executing projects, time spent reviewing articles, and any laboratory time."

[c] Calculated for clinical faculty only. We asked, "About how much time do you spend in a typical work week in direct patient care services: include all time you spend directly related to patient care. patient record keeping, patient related office work, travel time connected with seeing patients. Please exclude time on call when not actually working."

[d] We asked, "About how much time do you spend in a typical work week in administrative activities at your institution: include clinical and academic administration, faculty and departmental meeting and departmental meeting and committees."

[e] We asked, "About how much time do you spend in a typical work week in other professional activities outside your institution: include professional society activities, lecturing to outside groups, professionally related service on committees and advisory groups, and travel associated with the above."

[f] $p < 0.05$ for the comparison with the subgroup with no relationship.

[g] $p < 0.05$ for the comparison with all other subgroups receiving different levels of industry support.

EXHIBITS 5

Selected Measures Of Academic And Commercial Outcomes In 1985,1995, And 2006 (Unadjusted)

	Industry support	Research faculty using biotechnology tools			All research faculty	
		1985	1995	2006	1995	2006
Percent of faculty with industry support		23%	21%	17%^{a}	28%	20%^{b}
Mean number of publications	Yes	14.6^{c}	16.3^{c}	18.7^{c}	14.6^{c}	15.2^{c}
	No	11.3	10.8	12.0	10.1	9.9
Mean publication trends score	Yes	3.3	4.3^{c}	7.7^{c}	4.2^{c}	5.2^{c}
	No	2.2	2.2	3.3	2.1	2.9
Mean number of service activities	Yes	1.4	3.0^{c}	2.5^{c}	2.3^{c}	2.1
	No	1.1	2.0	1.8	1.8	1.6
Percent with patent applications	Yes	37%^{c}	56%^{c}	57%^{c}	42%^{c}	35%^{c}
	No	17	35	43	24	27
Percent with trade secrets	Yes	12^{c}	17.2^{c}	11.6	14.5^{c}	12.6^{c}
	No	3	6.6	7.3	4.7	7.4
Percent reporting choice Of research topics was somewhat or greatly affected by likelihood of commercial applications	Yes	30^{c}	30.0^{c}	23.3^{c}	35.1^{c}	27.3^{c}
	No	7	14.5	18.1	14.1	14.8

SOURCE: Authors' analysis of the 1985, 1995, and 2006 Academic-Industry Relationships Faculty Surveys: see Notes 8 and 21 in text.

[a] $p < 0.05$ for the comparison to 1985.

[b] $p < 0.05$ for the comparison to 1995.

[c] $p < 0.05$ for the comparison with the subgroup receiving no industry support.