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How are U.S. Technology Transfer Offices Tasked and Motivated— Is It All About the Money?

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ABSTRACT

We conducted a survey of directors of offices of technology transfer (TTOs) at U.S. academic institutions to determine how they are organized, tasked, financed, and motivated. We found some interesting quantitative data that have not been reported previously: (1) academic institutions spend on average 0.6% of their research budgets on transferring the technology resulting from their research programs, split 45% on patent protection and 55% on operating costs; and (2) over half the technology transfer programs bring in less money than the costs of operating the program, and only 16% are self-sustaining, bringing in enough income that, after distributions to inventors and for research, there are sufficient funds to cover the operating costs of the program. This leads to the surprising conclusion that the Bayh-Dole Act has been an unfunded mandate on academic institutions, and that academic institutions need to invest in their technology transfer operations in order to bring the benefits of their research to society.

We found that 20.3% of institutions are required to fund 50% or more of their operating budget from the income they generate, giving them an incentive to maximize income. The most important drivers of technology transfer are faculty service and translating the results of research, with only 11.5% reporting revenue maximization as the most important driver. We found that fewer than 20% of offices have incentive compensation plans, and only 28% of the performance factors that are taken into account in determining incentive pay are financial measures, with broader, non-financial performance measures accounting for 70% of the factors. Finally, a surprisingly large number of institutions do not have formal mission statements, but those that do establish broad, non-financial objectives for their offices, with only two institutions out of eighty (2.5%) having mission statements that establish revenue maximization as the objective of the offices.

We therefore conclude that although a small number of academic institutions have reaped very large rewards from their technology transfer activities—close to $4 billion in transactions that we were able to identify—these rewards appear to be a consequence of programs driven by broader objectives, and not a driving force for technology transfer as some have recently asserted. In our assessment, fewer than 10% of U.S. institutions' technology transfer programs are primarily motivated by financial return.

BACKGROUND— TECHNOLOGY TRANSFER IN THE UNITED STATES

In 1980, Congress enacted the Bayh-Dole Act[1] and allowed U.S. universities, teaching hospitals, and research institutes to have the automatic right to take title to inventions developed with federal funding. In response, these institutions have established offices to seek patent protection on these inventions and license them to existing and new businesses for development and commercialization. Since 1991, the Association of University Technology Managers (AUTM) has published an annual survey that has quantified the magnitude of this enterprise[2].

The AUTM annual surveys have documented important products that have resulted from Bayh-Dole, and other studies have quantified the considerable contribution to improving public health through the discovery, patenting, licensing, and successful development of approaching 150 small molecule and biological drugs, vaccines, and *in vivo* diagnostics (Jensen et al., 2007). In addition, key components of the Internet economy—web browsers such as Internet Explorer, portals such as Lycos, email such as Eudora, and search engines such as Google—were based on licensed university technologies.

Certainly some institutions have garnered substantial economic returns from technology transfer. The 2008 AUTM Licensing Activity Survey showed that, overall, U.S. academic institutions received $3.4 billion in licensing income. However, as the survey results also show, this income is highly concentrated in a small number of institutions that have had one big success, most often a drug—the so-called "big hit". In a relatively recent phenomenon, some of these institutions have accelerated receipt of the future royalty streams from these "big hits" through a sale of their royalty rights to either the marketer of the drug or to specialized investment partnerships and have received even larger, one-time "big hits". Recent lump sum payments have approached $1 billion. Table 1 summarizes some of these transactions and shows that institutions and their inventors have received almost $3.5 billion from such sales since 1999, with the pace accelerating in recent years.

Table 1. Major Royalty Sales by Academic Institutions and/or Their Inventors

Date	Product	Licensor	Amount ($ million)	
June 1990	Neupogen	Amgen	$75	
Dec. 1999	Zerit	Yale University[1]	$125	
Jan. 2001	Thalomid	Children's Hospital	$5	
Sept. 2003	Aldurazyme	LA Biomed[2]	$25	
Jan. 2004	Neupogen/Neulasta (U.S.)	Memorial-Sloan Kettering[3]	$263	
Jan. 2005	Macugen	University of Colorado[4]	$45	
Jan. 2005	Rotarix	Children's Hospital Cincinnati[5]	n/a	**
Jan. 2005	Rotateq	Wistar Institute[6]	$45	*
July 2005	Emtriva	Emory University[7]	$525	
Aug. 2005	Remicade	NYU/Dr. Vilcek	$46	**
Aug. 2005	Neupogen/neulasta (Non-U.S.)	Memorial-Sloan Kettering[8]	$142	
Oct. 2005	Humira	Scripps Research Institute[9]	$32	*
June 2006	Embrel (US)	MGH[10]	$248	
April 2007	Enbrel (Foreign)	MGH[11]	$284	
May 2007	Remicade	New York University[12]	$650	
July 2007	FluMist	U. of Michigan[13]	$35	
Dec. 2007	Lyrica	Northwestern[14]	$700	
Dec. 2007	Rotarix	Cincinnati Children's Hosp.[15]	$24	
June 2008	RotaTeq	Children's Hosp. of Phil.[16]	$182	
	Total		$3,451	

* Estimate

** Sale by inventor

[1]http://chronicle.com/weekly/v48/i06/06a02601.htm
[2]http://www.paulcapitalhealthcare.com/portfolio/overview.htm
[3]http://www.royaltypharma.com/media/pr/2004/MSKCC-01222004.pdf
[4]https://www.cu.edu/techtransfer/downloads/TechTransfer2005.pdf
[5]http://www.paulcapitalhealthcare.com/investmentcriteria/inventors/casestudies/cincinatti.htm
[6]http://webreprints.djreprints.com/1578940928144.html
[7]http://www.royaltypharma.com/media/documents/GileadSciencesandRoyaltyPharmaAnnounce525MillionAgreementwithEmoryUniversitytoPurchaseRoyalt.pdf
[8]http://www.royaltypharma.com/media/documents/RoyaltyPharmaAcquiresInternationalRoyaltyInterestinNeupogenandNeulasta.pdf
[9]http://www.scripps.edu/news/press/102605.html
[10]http://www.boston.com/business/technology/biotechnology/articles/2007/04/19/drug_nets_284m_for_mgh
[11]http://www.boston.com/business/globe/articles/2006/06/06/amgen_to_pay_mass_general_186m/
[12]http://www.royaltypharma.com/media/documents/Remicade-RoyaltyPharmaPurchaseofRemicadeRoyaltyFromNYU.pdf
[13]http://www.dricapital.com/show_info.php?page_id=28
[14]http://www.royaltypharma.com/media/documents/lyrica-royalty_pharma_purchase_of_lyrica_royalty_from_northwestern_university_december_18_2007.pdf
[15]http://www.paulcapitalhealthcare.com/newsroom/fundnews/012308.htm
[16]http://www.royaltypharma.com/media/documents/rotateq.pdf

Another source of "big hits" has been sales of equity, such as Dartmouth's $64 million sale of its equity stake in Medarex in 2000 and Stanford's sale of its $355 million equity stake in Google in 2005. Yet another has been legal settlements, such as the University of California's $200 million settlement with

Genentech over human growth hormone in 2000 and $30.4 million with Microsoft in 2007 over accessing interactive content on web pages, and the 1999 settlement between the University of Minnesota and Glaxo over Ziagen, valued at $300 million.

In spite, or perhaps because, of these financial successes, the involvement of academia in commercializing the results of its research has been controversial. Books written on the subject have blamed research commercialization for everything from increasing undergraduate tuition to destroying the public's trust in the objectivity of the advice and analysis it receives from professors (Bok, 2003; Krimsky, 2003, Washburn, 2005). Others, however, have documented the inherent entrepreneurialism of faculty (Shane, 2004), while others have demonstrated that only a minority of science faculty attempt to commercialize their research (Thursby & Thursby, 2003).

However, there has been little research on why institutions invest in the resources necessary to commercialize the results of their research. When university presidents speak publicly on the issue, they focus more on the public's right to see a return on the investment of their tax dollars in research grants via the availability of new products and services, rather than on the financial return that they might hope to see. For instance, Dr. Mary Sue Coleman, President of the University of Michigan, told the Annual Meeting of the Association of University Technology Managers in 2005 (Coleman, 2003):

> I think many people are often confused about why we are interested in technology commercialization, in nurturing start up companies, and in facilitating more patents and license agreements.
>
> It is not about the promise of future revenues that might be generated from this activity. You heard me correctly. It is not about the money.
>
> Of course, revenue generation serves as an incentive. But first and foremost, technology transfer must serve our core mission: sharing ideas and innovations in the service of society's well-being. In fact, at Michigan we expect to re-invest institutional gains back into technology transfer efforts. Revenue generation is NOT the ultimate goal. It is simply the means by which we can increase the transfer of new knowledge into the business sector.

A recent study by Litan, Mitchell, and Eddy of the Kauffman Foundation disputed Dr. Coleman's views and emphasized the role of financial incentive in technology transfer (Litan, Mitchell, & Reedy, 2007). The Foundation's website stated[4]:

> The emphasis among universities to reap big financial rewards through licensing and patenting innovation developed by research scientists is actually impeding the development of new technologies and may be masking the importance of other means of knowledge transfer.

The study went on to claim that universities are motivated in their technology transfer activities by the prospect of "the big hit". They stated:

> Where this has happened, it is because TTOs have been charged with concentrating too heavily on maximizing revenues from the licensing of university-developed intellectual property, rather than maximizing the volume of innovations brought to the marketplace.

Litan et al. described their research methodology as follows:

> We have spent the last several years discussing the role of TTOs with multiple university leaders and researcher-innovators.

As practitioners of technology transfer, Litan et al.'s conclusions did not comport with our experiences. One possible source for the discrepancy is that they appear not to have included in their discussions what is probably the most reliable source of information on what drives academic technology licensing offices—namely the leadership of those offices. While it certainly can be argued that technology transfer offices have a vested interest in preserving the status quo, it cannot be denied that they are a very important source of perspective on the subject, so we decided to carry out a systematic study to ascertain the role of various drivers of behavior in technology transfer decision-making, by surveying the individuals who lead those offices. As will become clear in this paper, Litan et al.'s conclusions do not comport with the findings of our research.

METHODOLOGY

We developed a survey instrument and implemented it in the SurveyMonkey system[5]. The questionnaire consisted of 17 questions that were a combination of multiple-choice questions and open-ended questions, some requesting quantitative data, some requesting qualitative information, and some requesting opinions. The questionnaire is available in the appendix.

We sent the survey, via email, to the Association of University Technology Managers' (AUTM) list of the most senior individual in each member institution who is responsible for technology transfer on a full time basis—the so-called "Director's List". The list is compiled from a number of sources:

- Self identification in AUTM's annual membership renewal process
- Self identification in registration for attendance at AUTM's annual meeting
- Identification by AUTM from the attendance list for the AUTM annual meeting

We applied to AUTM's Statistics and Metrics Committee for access to the Director's List, and our request was approved.

The list AUTM supplied to us was worldwide and contained some 702 entries. We first sorted it by country and then by institution, which yielded 425 entries ostensibly from the U.S. Inspection of the name of the institution or the individual's email address showed that 17 were in fact non-U.S. institutions and one was a for-profit corporation; for 16 institutions, two individuals were identified as the most senior licensing individual for the same campus at the same institution. In these cases, we selected one of the two by inspecting their respective job titles. This yielded 391 useable email addresses.

We launched the survey, via email invitation, on November 27, 2007. Reminders were sent, via email, on December 4, December 10, and December 12. Fifty-one responses were returned as "Undeliverable" or "I have retired". Therefore, 340 invitations to participate in the survey were presumably sent and received by the recipient.

A total of 165 usable responses were returned for a 48.5% response rate. Of these, 112 of the respondents replied to every question.

We downloaded the responses, sorted them by institution, and inspected the responses for duplicate responses from the same institution and campus and found none. When we observed obvious errors in the financial responses (for example, thousands instead of millions), we corrected them. In cases in which it was not clear what the respondent meant, we called the respondent to check the figure.

In this paper, we report the responses to every question and the number of responses received for each question. In the sections in which we looked for correlations between different types of performance and behavior, for consistency we analyzed only the 112 complete responses.

RESULTS

Respondents

Type of Institution

The first question asked was whether the respondent was a university, hospital, research institute or other. The results are shown in Table 2. The overwhelming majority of respondents were at universities.

Table 2. Type of Respondent

Type of Institution	Number	%
University	126	76.4%
Research Institute	23	13.9%
Hospital	14	8.5%
Federal Laboratory	2	1.2%
Total	165	

We next asked whether the institution was publicly owned or privately owned. The results are shown in Table 3. Publicly owned institutions made up more than 60% of the respondents.

Table 3. Ownership of Institutions

Ownership	Number	%
Private	63	38.2%
Public	102	61.8%
Total	165	

Organization of Offices

We then asked how the TTO was organized—whether it was an operating unit of the institution or an independent corporation such as a research foundation. The results are shown in Table 4. A total of 86% of the offices were organized as units of the institution and only 14% were separate corporations.

Table 4. Organizational Structure of Technology Transfer Offices

Organizational Structure	Number	%

Within Institution	142	86.1%
Independent corporation	23	13.9%
Total	165	

Of the 23 offices organized as independent corporations, all but one were associated with public institutions while one was associated with a private institution. Public universities are governmental entities and so are subject to certain contractual constraints. They frequently find it advantageous to assign ownership of and responsibility for licensing their intellectual property to a research foundation that is an independent 501(c)3 non-profit corporation and is not subject to the legal constraints of a governmental entity.

Finally, we asked how the office reported within the institution—through the academic side of the organization, i.e., ultimately to a Provost, or administratively, i.e., ultimately to a Vice President or Executive Vice President, or to an independent Board. The results are shown in Table 5. Reporting through the administrative side was somewhat more common, with a small proportion reporting directly to the President/Chancellor.

Table 5. Reporting Structure of Organizations

Reporting Structure	Number	%
Academic	55	33.7%
Administrative	81	49.7%
Independent Board	13	8.0%
Both/President/Chancellor	9	5.5%
Other	5	3.1%
Total	163	

Volume of Research Support

We asked the institutions to report the volume of their research. The total reported was $35.7 billion, which is 78.5% of the $45.4 billion in total research support that was indicated on the 2006 AUTM Licensing Activity Survey[6]. This demonstrates that our data are more representative of the totality of U.S. academic licensing activity than the 48.5% overall response rate would indicate. We note, however, that three federal laboratories reported to our survey—federal laboratories do not report to the AUTM Licensing Activity Survey.

Size of Technology Transfer Offices

We asked respondents to report the total employment of their offices, divided between professional staff and support staff. The total reported employment is shown in Table 6.

Table 6. Total Staffing of Reporting Institutions

Staff Category	Number of FTEs	Number Reporting
Professional Staff	729	153
Support Staff	587	134

Total	1,316

For comparison, respondents to the 2006 AUTM Licensing Activity Survey reported total employment of 1,831.7 FTEs, with support FTEs slightly exceeding professional FTEs. Respondents to our survey therefore employed 71.8% of the employment reported to AUTM, confirming the conclusion of the previous section that our data are more representative of total US technology transfer activity than the overall survey response rate would indicate.

For purposes of subsequent detailed analysis, we assigned size variables to institutions based on both the size of their total research expenditures and the basis of the total size of their technology transfer office. The cohorts and the number in each cohort are shown in Table 7.

Table 7. Cohort Definitions and Populations (Universities Only)

Cohort	Research Expenditures ($ million)	Number in Cohort	Total FTEs	Number in Cohort
Very Small	Up to $50	20	1–3	9
Small	$51–100	23	4–5	33
Medium	$101–250	45	6–10	42
Large	$251–500	24	10–24	36
Very Large	>$500	39	>25	34

Budgeting Process

The expenses of running a technology transfer office can be broadly divided between patent costs, normally spent externally, and personnel and other operating costs. We next asked respondents to tell us whether they had separate patent and operating budgets or were given a combined budget, implying they had the flexibility to spend their budget between the two categories as they saw fit. The results are shown in Table 8. A total of 60% of institutions had separate patent and operating budgets.

Table 8. Budgeting Procedures

Budget Procedure	Number	%
Separate Patent and Operating Budgets	78	60%
Combined Patent and Operating Budgets	53	40%
Total	131	

We next asked respondents how big their patent and operating budgets were. The totals for 114 institutions are shown in Table 9.

Table 9. Technology Transfer Budgets

Budget Category	Amount	%
Patent Budget	$93,636,000	44.2%
Operating Budget	112,838,500	53.3%
Unspecified	5,361,000	2.5%

Total	$211,835,500

Respondents reported spending roughly 20% more on operations—salaries, travel, services, etc.—than on patent protection. This is the first hard data that we've seen of the relative balance between personnel and legal expenditures in U.S. TTOs, though an extensive model developed by Brandt et al. based on staffing levels reported to the AUTM Survey combined with data from a number of surveys of technology transfer salaries (Brandt et al., 2005) came to a similar conclusion.

The 112 institutions that separately reported their operating budgets had total staffing of 925, implying an average operating cost per staff member of $121,988 annually.

For those institutions that reported their operating and patent budgets separately, we calculated the ratio of their patent budget to their operating budget. A ratio of 1:0 would indicate that an institution spent as much on patent protection as on operations. We found an extremely broad spread of values, reflecting an equally disparate spread of operating philosophies. As shown in Table 10, the range ran from a 6.4:1 ratio at one extreme[7] (though this was at an institution with a relatively low overall level of activity—$16k expenditures on patents and $3k on operations. The highest ratio at an institution with a substantial level of activity was 3.5:1—$700k on patents and $200k on operations) to a 0.092:1 ratio (expenditure of $60k on patents and $600k on operations) at the other extreme. The mean was 0.91:1.

Table 10. Variation in Ratio of Institutional Patent and Operating Budgets

Statistical Measure	%
Mean	91.9%
Median	60.0%
Std. Dev.	94.9%
Minimum	9.2%
Maximum	640.0%

Figure 1 shows the distribution of this ratio.

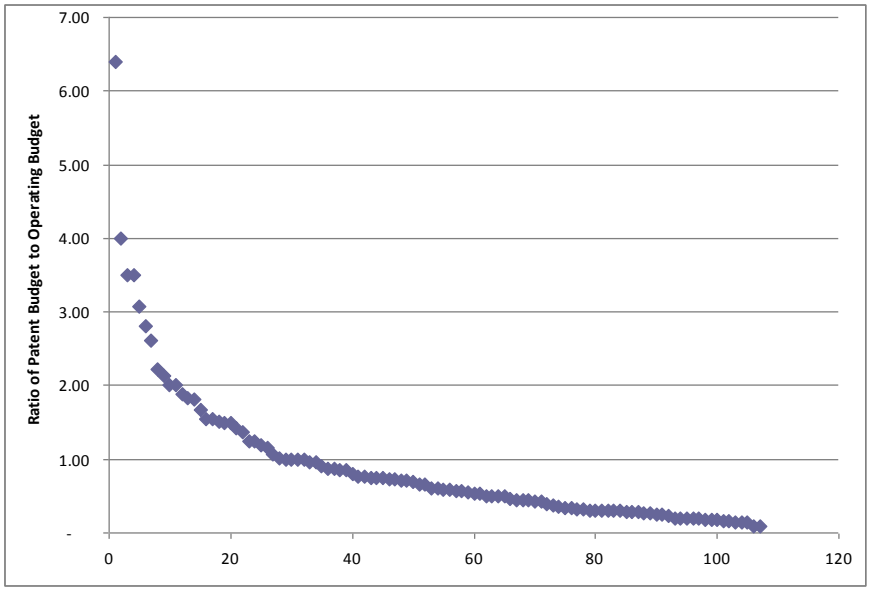

Figure 1. Ratio of Patent Budget to Operating Budget by Institution

The research budgets of the 116 institutions that reported their technology transfer budgets totaled $26.5 billion, implying that these institutions spend 0.59% of their research budgets on protecting and commercializing the results of that research.

As with the relationship between patent and operating expenditures, there is a considerable variation between institutions in the relationship between technology transfer expenditures and total research expenditures, from a high of 8% to a low of 0.01%. The distribution in this ratio is shown in Figure 2.

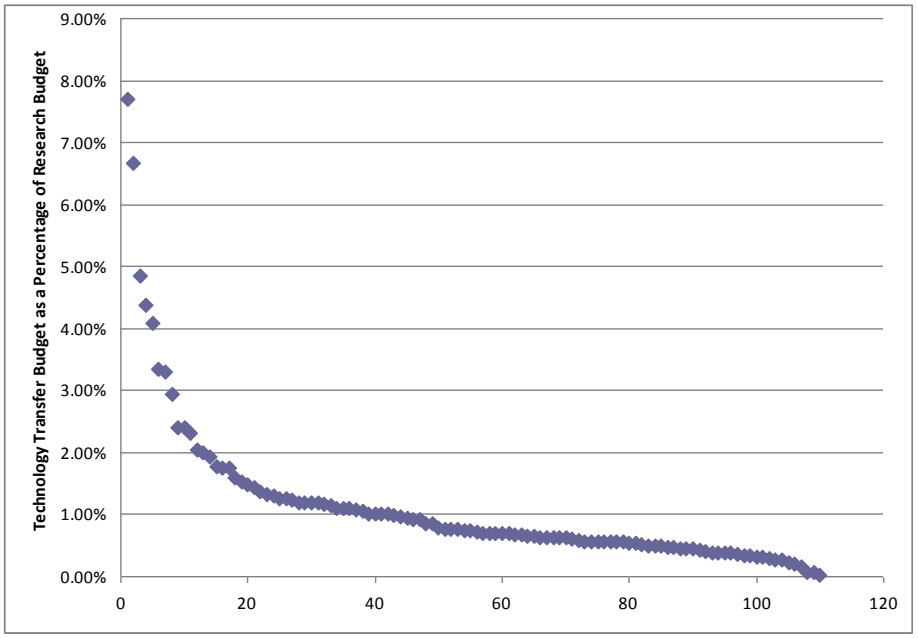

Figure 2. Technology Transfer Budget as a Percentage of Research Budget by Institution

Sources of Budget

Next we asked respondents how their technology transfer budgets were financed. One hundred and twenty six institutions reported the mechanism by which their budget was financed. The number of institutions reporting all or part of their budget coming from different sources is shown in Figure 3.

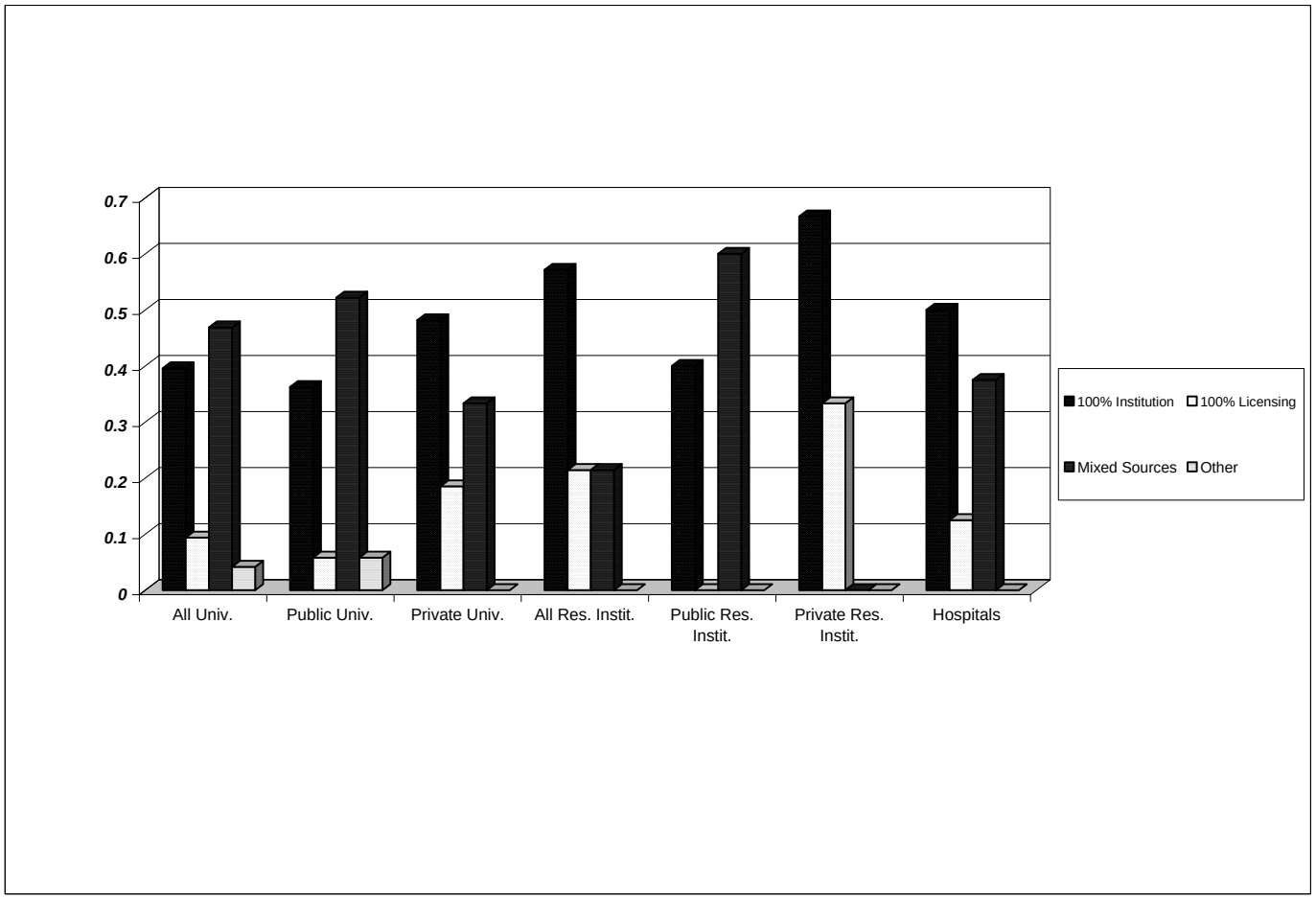

Figure 3. Sources of Technology Transfer Office Budget

This analysis shows that most TTOs receive their budget from a variety of sources. We found that 47% of universities receive part of their budget from the institution and part from licensing revenue. This reflects the reality (discussed in more detail below) that while many TTOs make money, few make enough to cover all of their expenses without some contribution from the institution. For Research Institutions, 57% are entirely funded by their institutions; at Hospitals, 38% are fully-funded by their institutions.

Factors Impacting How the TTO Budget is Financed

We examined the ways in which the source of the TTO budget correlated with the total research funding of the institution.

We found a very clear correlation between the size of a university's research budget and how its TTO is financed. As shown in Figure 4, at very small universities, over 60% of TTOs are entirely funded by the institution, while none are funded entirely by licensing income. In contrast, at large and very large universities, a significantly larger number of TTOs are funded entirely from licensing income, and relatively few are funded entirely by the institution.

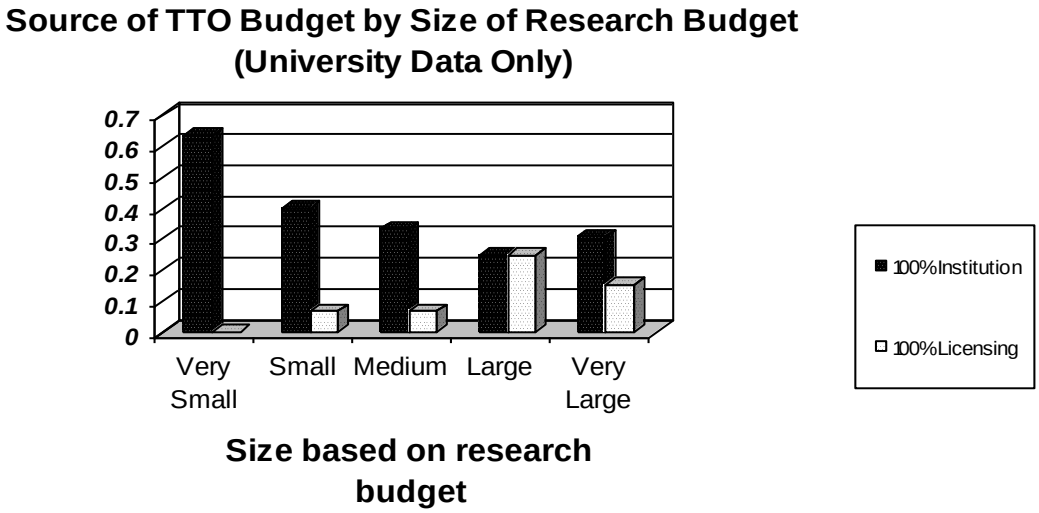

Figure 4. Source of TTO Budget by Size of University Research Budget

Operating Results

We did not ask for data on income generated by the offices from their licensing activities. However, we did ask respondents to report the financial contribution their office made to its institution.

As discussed by Brandt et al., the profitability of an office depends on the view taken of income. There are many claims on licensing income. As a requirement of Bayh-Dole, one portion of licensing income must be shared with inventors. The balance is required to be spent on research and education, which in practice means that part of the income is shared with some combination of the inventor's laboratory, department. and college to be spent on research, with the institution retaining only a portion to offset the operating costs of the office. The financial contribution of the technology transfer operation to the institution therefore depends on whether the calculation includes the portion of income that goes to the inventors, the portion of income that is distributed and spent on research, or just the portion that is retained to reimburse the patent expenditure and operating costs.

We therefore asked the institutions to characterize their financial performance as follows:

Category	**Definition**
Loss Making	Total expenses exceed total income
Gross Profitable	Total income exceeds total expenses
Net Profitable	Total income less distribution to inventors exceeds total expenses
Self-Sustaining	Total income less distribution to inventors, colleges/labs, provost, university etc. exceeds total expenses

The results are shown in Table 11. Over 50% lose money on their technology transfer operations, while only 16% are self-sustaining, retaining more from net income after distributions to inventors and for research than is spent on patent protection and operating costs. These results show that technology transfer is considerably less financially beneficial to institutions than was predicted by the Brandt et al. model, which predicted that only 42% were loss-making and that 30% of institutions were self-sustaining.

Table 11. Financial Contribution to Institution from Technology Transfer

Financial Contribution	**Number**	**%**
Loss making	68	52.3%
Gross profitable	27	20.8%
Net profitable	14	10.8%
Self sustaining	21	16.2%
Total	130	

Factors Impacting Profitability

We found that research institute TTOs were more profitable than those at universities and hospitals, and that private institutions were more likely to be profitable than public institutions, as shown in Figure 5.

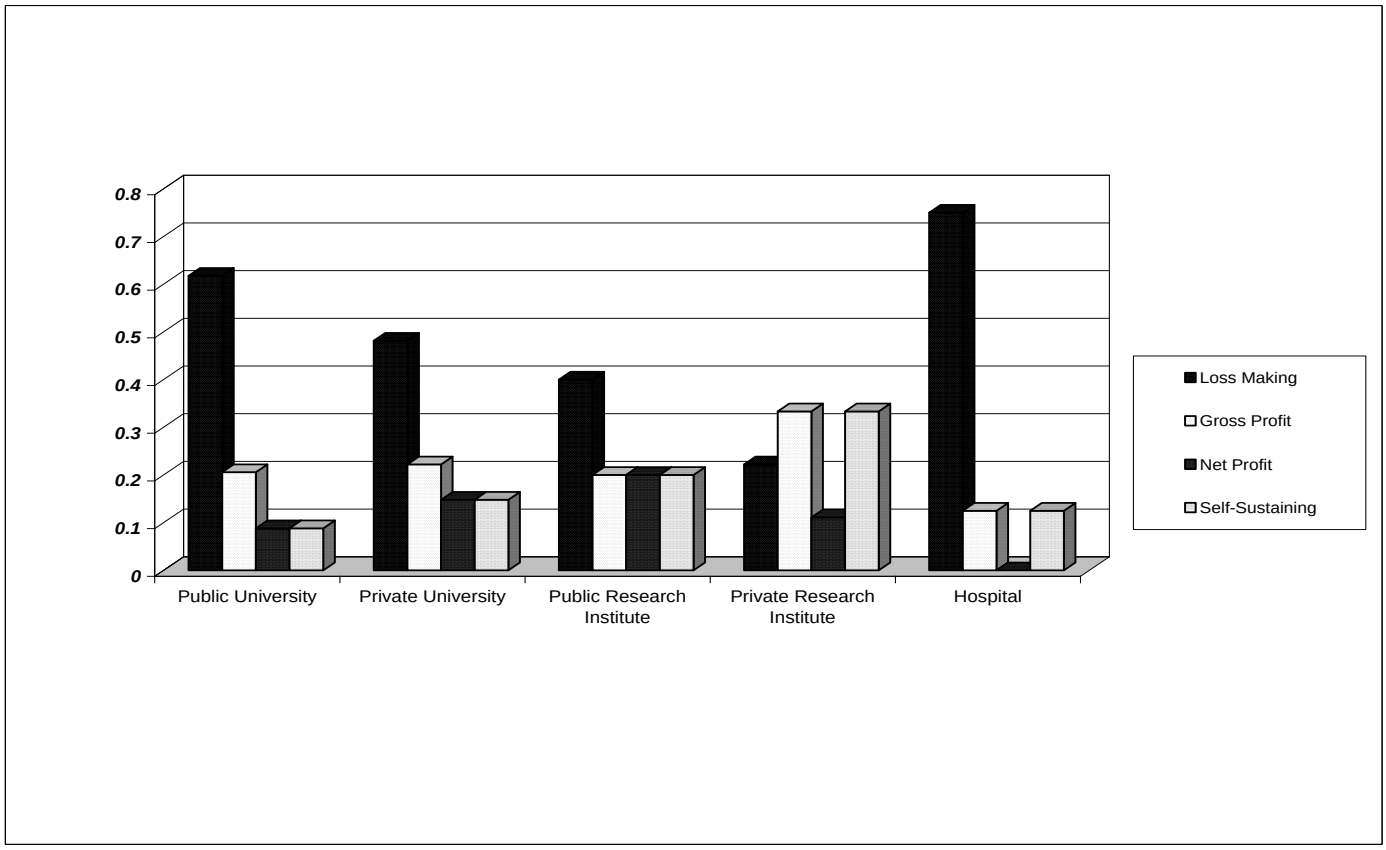

Figure 5. Profitability of TTOs by Institution Type

We found a direct correlation between the size of an institution's research budget and its profitability. The larger the research budget, the more likely the office was to be profitable, as shown in Figure 6. At very large schools, 15% are loss-making, and 31% are self-sustaining. By contrast, at very small schools, 76% are loss-making and none are self-sustaining. The relationship between size and profitability is almost linear—as the research budget of the institution increases, the profitability of the TTO increases.

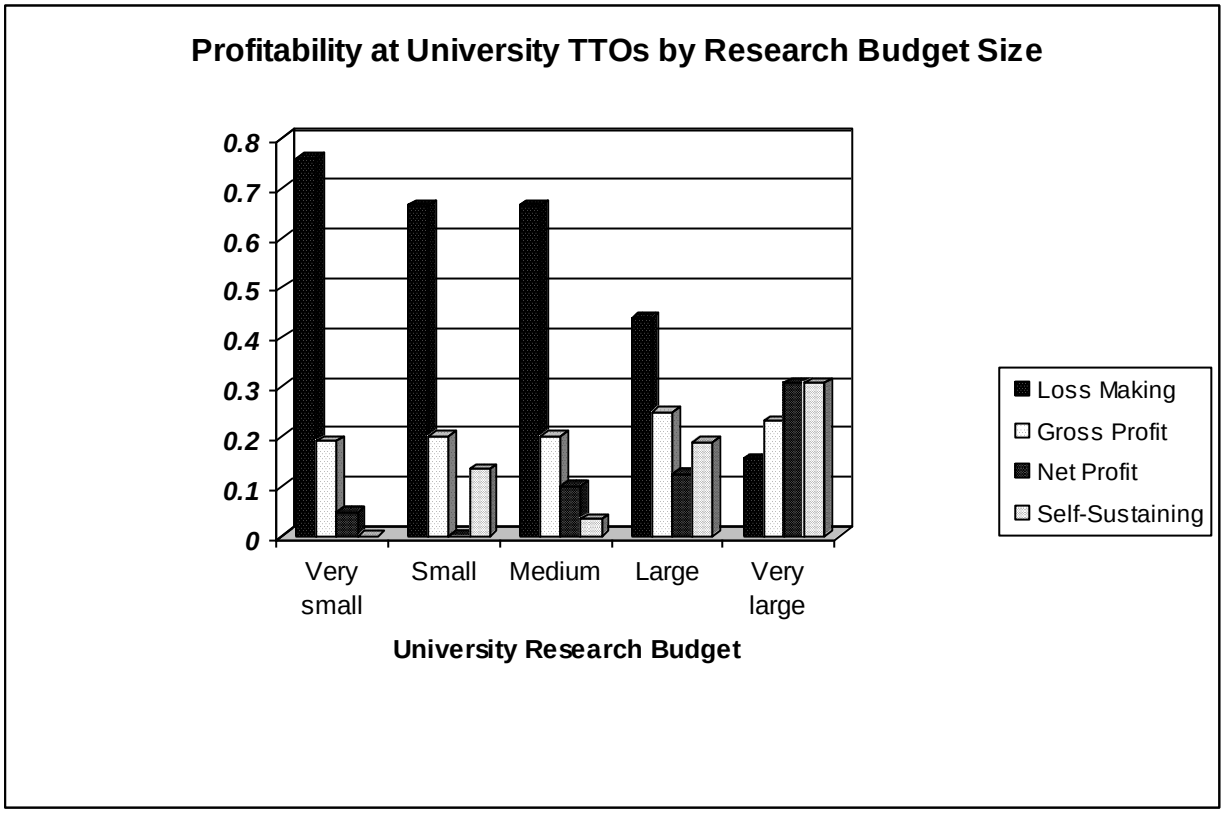

Table 6. Profitability of University TTOs by Research University Budget

We also looked at how the profitability of TTOs correlates with the size of the office. The results are shown in Figure 7. We found that the correlation between TTO profitability and office size closely follows the correlation between profitability and total research budget. None of the very large universities are operating at a loss, and none of the very small universities are self-sustaining.

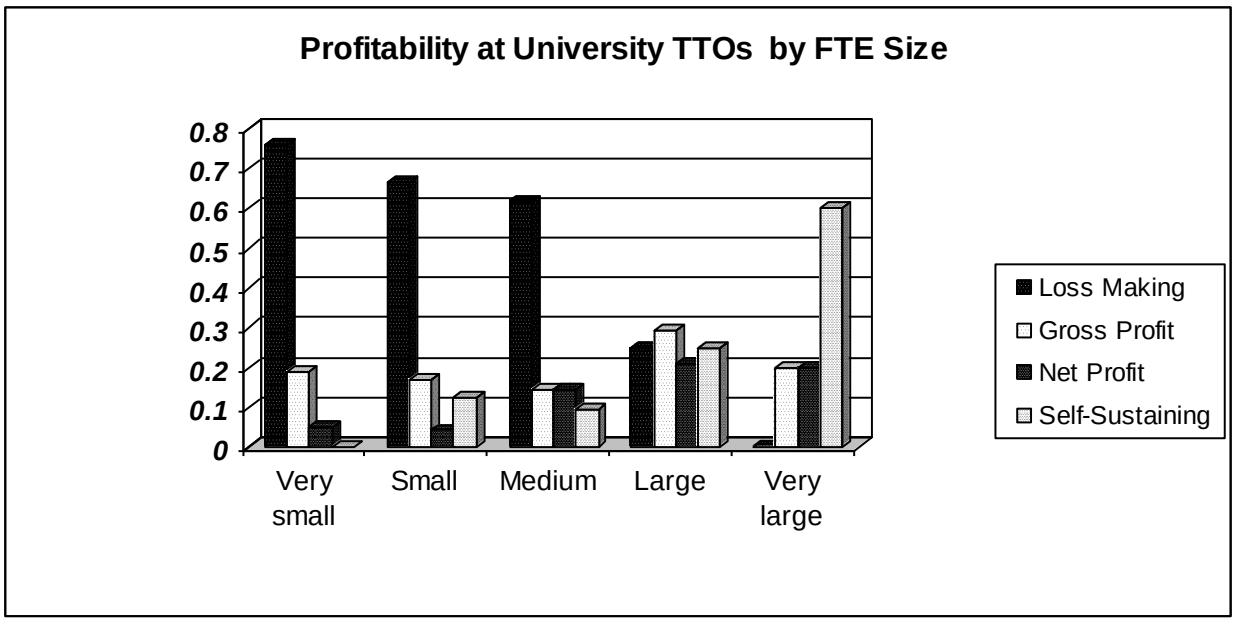

Figure 7. Profitability of University TTOs by FTE Size

This conclusion confirms the findings of Brandt et al., who found that the greater the age, FTE count, and research budget of a TTO, the more likely it was to be profitable. Further, they discovered that the TTOs of only those institutions that were 15 years old *and* had a research budget greater than $500 million *and* had a total staffing of 20 FTEs were all profitable—a very stringent set of conditions.

Reinforcing the relationship between staffing levels and profitability, a 2006 study by the Milken Institute (DeVol et al., 2006) went so far as to calculate that an incremental investment of $1 in TTO salaries would generate an additional $6 in license income.

We also looked at the relationship between reporting structure and profitability and found no significant correlation.

Drivers of Technology Transfer

The next section of the survey dealt with the informal drivers of technology transfer in an institution. By asking directors of TTOs for their rankings of the possible drivers of behavior, we hoped gain an understanding of how TTOs prioritize the forces shaping their behavior in their daily decision-making.

First, we asked the respondents what drives the TTO. Respondents were asked to rank six factors in order of priority from 1 to 6:

- Revenue maximization
- Faculty service
- Research results translation
- Industrial sponsored research income

- Risk management
- Other

Table 12 shows how many institutions ranked each factor as the most important driver of their office. Faculty service was ranked first most often, followed by translating research results. Maximizing revenue was ranked most important by only 11.5% of institutions.

We did not include "Economic Development" as an option, which anecdotally is reported to be a significant driving force at publicly owned institutions. This may explain the relatively high number of "Other" responses.

Table 12. Top-Ranked Drivers of Technology Transfer

Driving Factor	Number of Institutions Ranking Factor First	%
Faculty Service	51	39.2%
Translating Research Results	45	34.6%
Revenue Maximization	15	11.5%
Other	15	11.5%
Research Support	4	3.1%
Risk Management	0	0.0%
Total	130	

Factors Impacting Drivers of Technology Transfer

As shown in Table 13, the drivers were broadly similar for both universities and research institutions, with research results translation being the most important factor at research institutions while faculty service was most important at universities. At hospitals, research results translation was again the most important factor, while financial factors—revenue maximization and research support—were relatively more important than they were for universities and research institutions.

Table 13. Top-Ranked Driver of Technology Transfer by Type of Institution

Type of Institution	Top-Ranked Driver
Public Univ.	Faculty Service
Private Univ.	Faculty Service
Public Res. Inst.	Research Results Translation
Private Res. Inst.	Faculty Service
Hospital	Research Results Translation/Other

As shown in Figure 8, as the size of the university increases, the top driver changes from Faculty Service (over 60% in small and very small universities) to Research Result Translation (35% and 54%, respectively, at large and very large universities). The choice of Revenue Maximization as the top driver

increases linearly from very small to large schools, but is not a factor at any very large schools. Industrially Sponsored Research Income was listed as the top driver at so few schools that we regarded it as not significant.

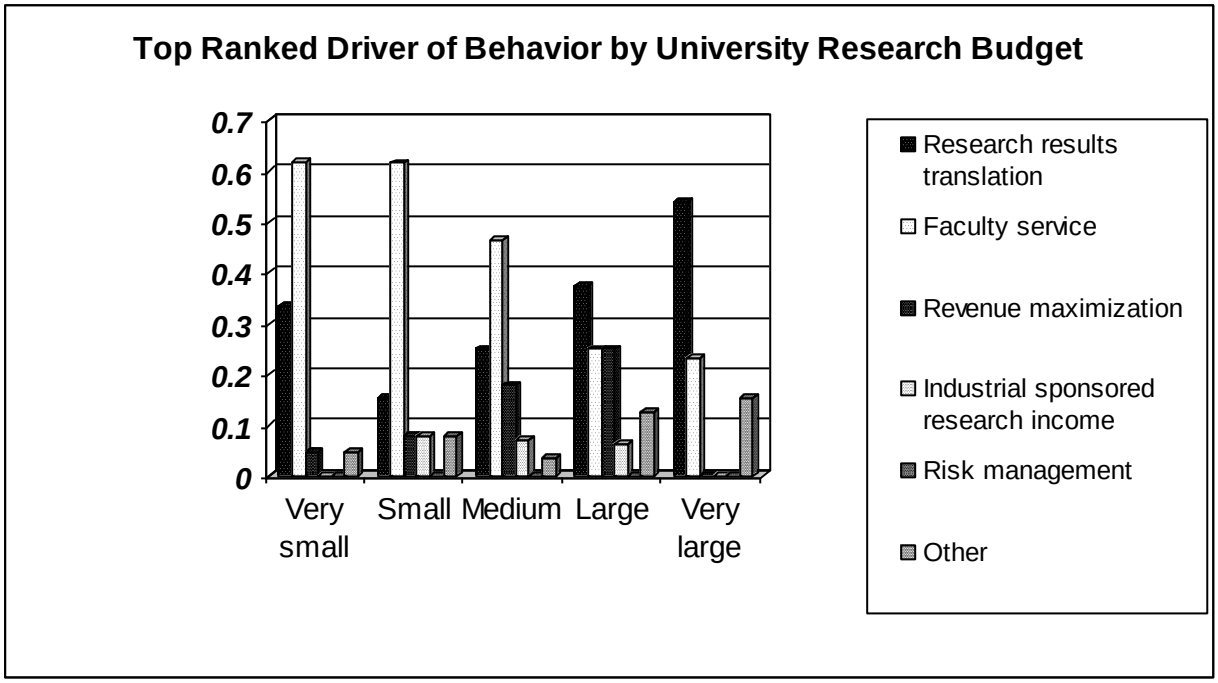

Figure 8. Top Ranked Driver of Behavior by University Research Budget

As shown in Figure 9, when we compared public and private universities, we found that Faculty Service is the top-ranked driver at a much higher rate at private universities than at public universities (56% vs. 41%, respectively), and Research Result Translation is chosen by a greater number of public universities than private universities (34% vs. 26%). Revenue Maximization was listed at the number one driver at 14% of public universities versus only 7% of private universities.

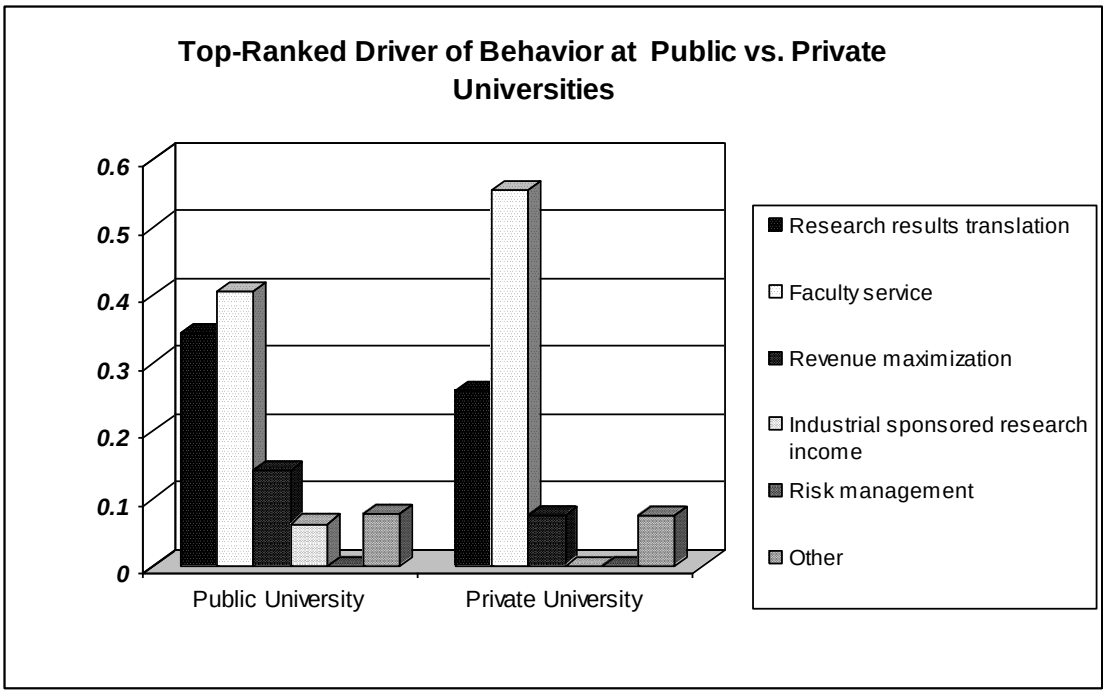

Figure 9. Top-Ranked Driver of Behavior at Public vs. Private Universities

As shown in Figure 10, when we looked at the top-ranked drivers of TTO behavior we found a steady decrease in the importance of faculty service to research results translation as total research expenditures increase.

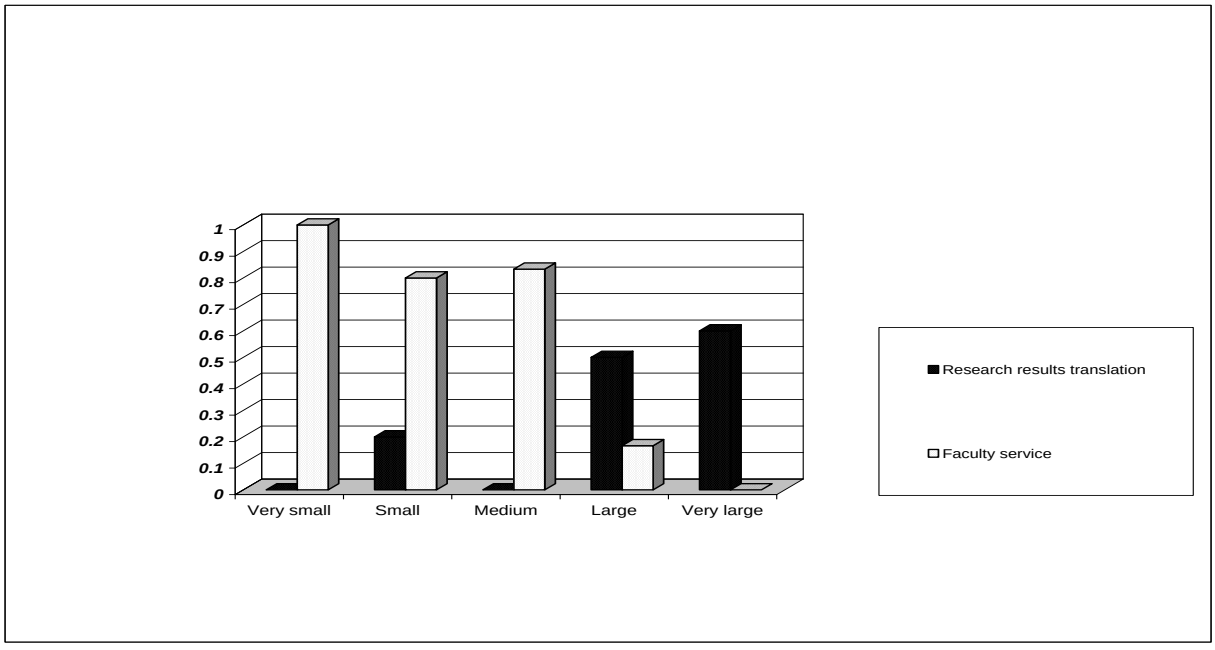

Figure 10. Effect of Research Budget Size on Top-Ranked Driver of Behavior

at Public Universities

We looked at whether the top driver of TTO behavior correlated with the organizational structure—i.e., do the priorities of the TTO change if the TTO reports to the administrative side of the university versus reporting to the academic side, and found no significant difference.

Finally, we examined whether having revenue maximization as the top driver of technology transfer translated into enhanced profitability. The results are shown in Table 14. There is no clear correlation between the two.

The results of these analyses show that an industry standard seems to have been adopted throughout the profession. Translating research results and providing a service to the faculty are clearly the primary drivers of TTO behavior, whether the TTO is large or small, private or public, or whether it is making money or losing money.

Table 14. Top Drivers of TTO Behavior Based on Profitability (All Institutions)

Profitability	No.	Research Result Trans.	Faculty Service	Revenue Max-imization	Industrial Sponsored Research	Risk Management	Other
Loss-Making	58	31%	45%	12%	9%	0%	7%
Gross Profit	24	33%	38%	8%	0%	0%	13%
Net Profit	12	33%	42%	25%	0%	0%	8%
Self-Sustaining	18	33%	39%	11%	0%	0%	17%
Total	112	32%	42%	13%	4%	0%	10%

Technology Transfer Office Mission

We next asked institutions if the technology transfer office has a formal mission statement. The results are shown in Table 15. A surprising number of offices do not have a formal mission statement.

Table 15. Technology Transfer Offices with a Formal Mission Statement

Formal Mission Statement	Number	%
Yes	75	58.6%
No	53	41.4%
Total	128	

We next asked those offices that have a formal mission statement to provide us with information on their mission statement. While only 75 institutions answered yes to this question, 80 submitted a copy of their mission statement.

The following are typical of the mission statements we received:

> The XXXX Office of Technology Transfer promotes and supports the research enterprise at the University by creating relationships with the private sector to develop, protect, transfer and commercialize research results for the public benefit.

> As a service provider, assist XXXX, its researchers, and its community partners with the development and promotion of biomedical innovations.
>
> - "Support the educational, research, and healthcare mission of the University by fostering creativity and innovation.
> - Initiate and sustain cooperation and collaboration between the University and business and industry.
> - Act as the University's intellectual property management and technology marketing arm.
> - Advance healthcare-related economic development for our state and the nation.
> - Support economic development through technology licensing."
>
> It is the mission of the TTO to encourage broad practical application of System research for public benefit; to encourage and assist those associated with the System in the protection, licensing and commercialization of their discoveries; to ensure the equitable distribution of royalties and other monetary benefits resulting from the commercial application of intellectual property; and to see that commercialization activities benefit the research, education and outreach missions of the System into the future.

We searched all of the mission statements for keywords such as "value", "income", "revenue", "financial return" and "maximize" that would speak to a focus on financial return. We found mission statements such as:

> Promoting the transfer of XXXX's life science & medical technologies for public use and benefit, while generating ***income*** to support campus research and education.
>
> Our mission is to help facilitate scientific research at the Institute, promote transfer of Institute basic research discoveries to the marketplace for the public benefit, and generate ***revenue*** for further research.
>
> - To facilitate the movement of Institute's inventions from research to application.
> - To create ***value*** in the inventions by protecting them with patents and ensuring Institute's ownership rights.
> - To commercialize Institute's intellectual property in accordance with Institute's mission and external granting agency guidelines (NIH, NSF, HHMI).
> - To generate ***revenue*** for Institute, its inventors and its continued research through commercial licensing.
> - To facilitate development of the local Biotechnology Industry and economy. *(emphasis added in each case)*

The term *financial return* did not occur in any of the mission statements, and the words *maximum* and *maximize* each occurred only once in each of two mission statements that were the only ones that seemed to establish maximizing financial value and return as the mission of the office.

> To ***maximize*** the ***value*** of XXXX's intellectual assets through the creation of novel and effective models for commercializing technology.

The essential mission of the Office of Technology Transfer is twofold:

(1) to promote the timely transfer of commercially valuable knowledge and inventions developed in the University to the businesses most capable of reducing them to practice and benefiting the economy of XXXX and the nation, and

(2) to return ***maximum value*** for such commercialization to the inventor/s and to the University in support of its continuing research enterprise, in a manner which upholds sound ethical, legal, and academic standards. The value of technology licensing for the University includes its benefits in providing incentive to faculty for research and invention as well as the dollars received for financing continuing University research activity. *(emphasis added in each case)*

Incentive Compensation

The final section of questions concerned incentive compensation. We first asked whether any personnel in the office receive incentive compensation. The results are shown in Table 16. Clearly only a minority of personnel receive bonuses.

Table 16. Offices in Which Some Personnel Receive a Bonus

Do Some Personnel Receive a Bonus	Number	%
Yes	22	17.2%
No	109	85.2%
Total	131	

Next we asked how many personnel in the office receive bonuses and compared the answer with the reported number of staff. The results are shown in Table 17. Clearly, in the relatively small number of offices that offer bonuses, bonuses tend to be offered broadly within the office.

Table 17. Availability of Bonuses within the Office

Number Receiving Bonus	Number	%
All	9	40.9%
More than the Professional Staff	3	13.6%
All Professional Staff	2	9.1%
Fewer than All Professional Staff	2	9.1%
One	6	27.3%
Total	22	

Next we asked how the bonuses were calculated. First we asked whether they were calculated based on office performance, individual performance, or a combination of the two. The results are shown in Table 18. Clearly, the most prevalent practice is to incentivize a combination of total office performance and individual performance.

Table 18. Basis for Computation of Bonuses

* One respondent answered "NO" to question about having an office bonus scheme, but then gave details of a bonus scheme—that it was available to all professional staff and that it was based on overall office performance.

Calculation Basis	**Number**	**%**
Individual performance	2	8.7%
Office performance	4	17.4%
Combination of office + individual	17	73.9%
Total	23*	

Finally, we asked for information on the bases on which bonuses are calculated. From a list of five specific factors, we asked whether each was taken into account in calculating bonuses and, in addition, allowed respondents to identify one of more "other" factors. Respondents could identify as many factors as were relevant to their experience.

To analyze the data, we first reviewed what was entered in the "other" column, and entered the count for the number of specific factors identified by respondents.

Twenty one of the 22 respondents who reported that they had an incentive compensation plan identified the factors taken into account in computing incentive compensation. The 21 respondents reported 81 factors that were taken into account. A statistical analysis of the responses is shown in Table 19. Both the mean and the median Incentive Compensation Plans took into account four factors, though several only took into account one factor and one plan took into account eight factors.

Table 18. Number of Factors Taken into Account in Calculating Incentive Compensation

Measure	**Value**
Mean	3.90
Median	4.00
Std. Dev.	2.57
Min	1.00
Max	8.00

As shown in Table 20, the most common factor taken into account in computing Incentive Compensation was "Other", followed by Total Income and Transactions Completed, followed by Disclosures Received.

Table 19. Factors Taken into Account in Awarding Incentive Compensation

Factor	**Number**	**%**
Other	18	22.2%
Total income	14	17.3%
Transactions completed	14	17.3%
Disclosures received	10	12.3%
Operating surplus	9	11.1%
Faculty satisfaction	9	11.1%
Start-ups formed	7	8.6%
Total	81	

The "Other" category included the following, several of which were cited by multiple respondents:

- Beneficial products and services introduced to society
- Community service
- Exclusive licenses
- Faculty education activities
- New revenue
- Overall university financial performance
- Performance against specific targets
- Regional economic impact

Only two of these factors—Total Income and Operating Surplus—are financial return-oriented and account for 28.4% of the factors cited, while the remaining 10 are oriented toward broader measures of technology transfer performance.

ANALYSIS AND DISCUSSION

Our methodology was designed to make four independent determinations of the behavior of technology transfer in an institution through four independent sets of questions:

- How is the office financed?
- What drives the office—i.e., what behavior is the office actually demonstrating?
- What are the office's incentives based on—i.e., what behavior does the institution really want and is prepared to pay extra for?
- What is the official mission of the office—i.e., what behavior has the institution told the office it wants from it?

First, looking at the sources of the TTOs' operating budget, we found that 20.3% of offices are required to generate between 50% and 100% of their operating budgets from their license income. These institutions clearly have an incentive to maximize the income they generate simply in order to stay in business.

Next, looking at the actual behavior the offices displayed, we found that the most important drivers of technology transfer were faculty service and translation of research results. Only 11.5% of offices stated that maximizing revenue was the most important driver of technology transfer.

Third, looking at the behavior the institution really wanted and was prepared to pay extra for to obtain, we found that fewer than 20% of institutions provided incentive compensation to their TTOs; among those that did, only 28% of the factors taken into account in determining incentive compensation focused on financial return, with the remainder focused on broader, non-financial measures of performance. This means that only 5.6% of offices were incented based on financial performance.

Finally, the most visible way to make income important is to put it in the TTO's mission statement. While a surprisingly high percentage of TTOs had no formal mission statement, only 2 out of 80 institutions that did have a formal mission statement—2.5%—mentioned maximizing income or revenue

in their mission statement. This proportion falls to 1.6% of the 128 institutions that gave either a "yes" or "no" answer to the question on whether they had mission statements.

The results of these four separate determinations are summarized in Table 21:

Table 20. Summary of Estimates of Extent to which Behavior is Driven by Income

Area of Investigation	Extent Driven by Income
Operating Budget	20.30%
Drivers	11.50%
Incentive Compensation	5.60%
Mission Statement	2.30%

CONCLUSION

The results of these four independent determinations were consistent in demonstrating that financial return is not the major factor in technology transfer organization and behavior, as is often posited. There is a very clear trend in our results and an obvious conclusion to be drawn from them, namely that the more visible the factor we used to determine TTO behavior, the lower the frequency with which we found income maximization to be the most important factor.

- The most indirect way of encouraging revenue maximization is to make the operating budget of the TTO dependent on the income it generates. This had the highest incidence—20.3% of TTOs were required to generate half or more of their operating budget from the income they generate.
- Also subtle were the priorities that the TTOs reported as driving their activities; here only 11.5% of TTOs reported that revenue maximization was their most important driver.
- Including revenue maximization as part of an incentive compensation program means that an institution has made a formal, senior-level determination that it wants the TTO to maximize revenue, and is a much more overt measure. We found revenue maximization accounted for only 5.6% of incentive compensation.
- Finally, the most visible and public statement of an institution's desire for its TTO to maximize revenue is to include revenue maximization in the TTO's mission statement. Only 2.3% of the mission statements we were sent included revenue maximization as one of the TTO's missions.

We therefore conclude that, depending on the visibility of the measure of what drives the TTO, from 2.3% to 20.3% of technology transfer activities are driven by financial considerations, with most activity being driven by broader objectives such as translation of research results and service to the faculty. Which of these four very different figures represents the "best" measure? The average of the four figures is 9.9%, which is reasonably close to the 11.5% of TTOs that reported revenue maximization as the primary driver of their activities. If someone wanted to summarize our findings in a Twitter, we would suggest, "Only 10% of technology transfer activity in the U.S. is driven by revenue maximization"—or

perhaps its corollary, "90% of technology transfer activity in the U.S. is driven by social rather than revenue considerations."

We therefore respectfully disagree with the conclusions reached by Litan et al. discussed in detail earlier, in which they concluded that:

> …TTOs have been charged with concentrating too heavily on maximizing revenues from the licensing of university-developed intellectual property, rather than maximizing the volume of innovations brought to the marketplace (Litan et al., 2007, n.p.).

In our research we found the direct opposite—that translating the results of research and servicing faculty are the primary drivers of technology transfer offices.

We believe these results are not surprising in light of the way technology transfer is organized in the U.S. Fewer than 15% of TTOs are organized as independent corporations. An independent corporation can develop a culture that is quite distinct from that of the parent institution, whereas if the TTO is an integral part of the institution, it will inevitably share its culture. Outside the U.S., particularly in the UK and Australia, independent corporations tend to be the preferred TTO model. The extreme example of an independent corporation is Imperial Innovations, PLC, the technology transfer arm of Imperial College, London, which is an independent corporation that is publicly traded on the Alternative Investment Market of the London Stock Exchange[8]. Clearly, Imperial Innovations has a fiduciary responsibility to its shareholders to maximize its profits, and it can no longer hew to the university's charitable mission.

Finally, we confirmed an earlier study that found that for over half of institutions, technology transfer is actually a cost to the institution rather than a source of income and that only 16% of institutions ***retain*** enough of their income to reimburse all the costs of operating their TTOs, after sharing their income with various stakeholders, such as inventors, labs, and the university.

We therefore predict that institutions which established their TTOs in the expectation of a "big hit" are likely to be disappointed; however, institutions that establish their offices with a broad set of goals will likely see their objectives realized.

We should conclude with a caveat. The above findings and conclusions should not be interpreted as implying that TTOs do not care about the financial terms of the license transactions they negotiate and will "give" the technology away. Far from it. Technology transfer offices have a strong sense of fairness and will fight hard to ensure that their institution shares fairly in the fruits of success if their technology is successful in the marketplace. Rather, our conclusions mean that income is not the primary motivator of offices; technologies with smaller market potential will receive as much attention as those that serve large markets; if there is a single, credible potential licensee interested in a technology, then the office will negotiate exclusively with that company rather than seeking additional licensees to create a competitive bidding situation; junior faculty will receive as much attention as senior faculty; and non-financial, academic and social considerations will be taken into account in negotiating deals.

Public Policy Implications

Although it was not one of the objectives of our research, our study has important public policy implications for the role of academic research in innovation ecosystems, both in the U.S. and globally. The Bayh-Dole Act was intended to break down the Chinese walls that had grown up between academic and corporate research and to integrate academic innovation into the U.S.'s innovation ecosystem. While it is beyond the scope of this article to discuss the economic impact of Bayh-Dole, studies have shown that it has succeeded admirably in this regard (Bayh, Allen, & Bremer, 2009; Jensen et al., 2009; Roessner et al., 2009). However, our study leads to the surprising conclusion that Bayh-Dole has turned out to be an unfunded mandate on U.S. academic institutions.
Bayh-Dole provided no direct funding for the technology transfer activity it was about to trigger. It was anticipated that the costs of technology transfer would be included in each institution's indirect cost base and that, subsequently, licensing income would rise to cover the costs of the activity. Two factors changed this expectation:

1. The administrative component of indirect costs was capped at 26% in the early 1990s—IDC no longer covers the complete costs of carrying out research. A recent study found that U.S. patent costs are only included in the IDC base at three U.S. academic institutions.
2. Equally, licensing income has not grown fast enough to cover the cost of the technology transfer function at most institutions, for several reasons (Stevens, 2003).

Licensing income grew slowly for several reasons. First, it took time for academic institutions to establish TTOs. The AUTM Annual Licensing Survey shows that the first wave of technology transfer offices were created fairly evenly over a thirteen-year period centered on 1990 (running from 1983 to 1996), not immediately after the passage of Bayh-Dole in 1980. TTOs continued to be created after 1996, albeit at a much slower rate, though there was another spike of start-ups in 1999 and 2000. Next, once TTOs were established, it took time to recruit and train staff, for a culture of technology transfer to develop on campuses, and for a portfolio of licensable inventions to develop. Then, because academic inventions are generally very embryonic and leading (bleeding?) edge, it generally takes from one to four years to find a licensee to make a commitment to develop a technology. And finally, since the majority of the most valuable academic inventions have been drugs, they have had to go through the 10- to 15-year clinical testing and FDA approval process.

The next issue is that few licenses generate substantial income. AUTM data show that only around 1% of licenses generate more than $1 million in income in any given year[9]. While this may sound substantial, a typical TTO would distribute around $750,000 of the $1 million to inventors and for research and only retain around $250,000 to cover TTO patenting and operating costs. The data in Table 1 shows that the incidence of the truly "big hits" is even more unevenly distributed and is primarily concentrated in a relatively small number of institutions that have created important drugs and vaccines.

Finally, only a relatively small amount of license income is used to offset the costs of technology transfer. At most institutions, 60–75% of income is distributed to the inventors to incentivize them to participate in the technology transfer process, and to laboratories and colleges to be spent on further research.

This issue also has implications outside the U.S. Over the past decade, many countries, initially in Europe and now in developing countries, have adopted the institutional ownership model of academic invention management pioneered by Bayh-Dole. Many have recognized this financial dilemma and have

provided funding to kick-start the process. However, most have made the same assumption that the U.S. Senate did, and have provided funding for only relatively short periods of time—typically five years. Normally the TTOs are still well short of self-sustainability when the funding runs out and difficult decisions then have to be made.

We conclude, therefore, that new funding models for technology transfer are needed, both domestically and outside the U.S.

AUTHORS' NOTE

We thank the Association of University Technology Managers for providing us with access to its Directors List, and Janine Anderson, Boston University, for her meticulous proof-reading of the manuscript.

END NOTES

1. P.L. 96-517, Patent and Trademark Act Amendments of 1980; see, for instance, http://www.autm.net/aboutTT/aboutTT_bayhDoleAct.cfm
2. http://www.autm.net/about/dsp.licensing_surveys.cfm
3. http://www.paulcapitalhealthcare.com/newsroom/fundnews/012308.htm
4. http://www.kauffman.org/items.cfm?itemID=786, accessed 12/22/07.
5. http://www.surveymonkey.com/
6. http://www.autm.net/about/dsp.pubDetail2.cfm?pid=41
7. One institution reported a patent budget of $600k and an operating budget of only $37k despite reporting two professional and one support FTE. It appears that they misunderstood the question and reported only their "All other" budget and not their total operating budget, and we did not include these data.
8. Imperial College owns 51% of the company's stock.
9. For instance, the 2008 U.S. Annual Licensing Activity Survey found that of 15,498 licenses that were generating income, including 7,917 licenses that were generating running royalties (i.e., had advanced to a marketed product), only 192 licenses generated more than $1 million in income.

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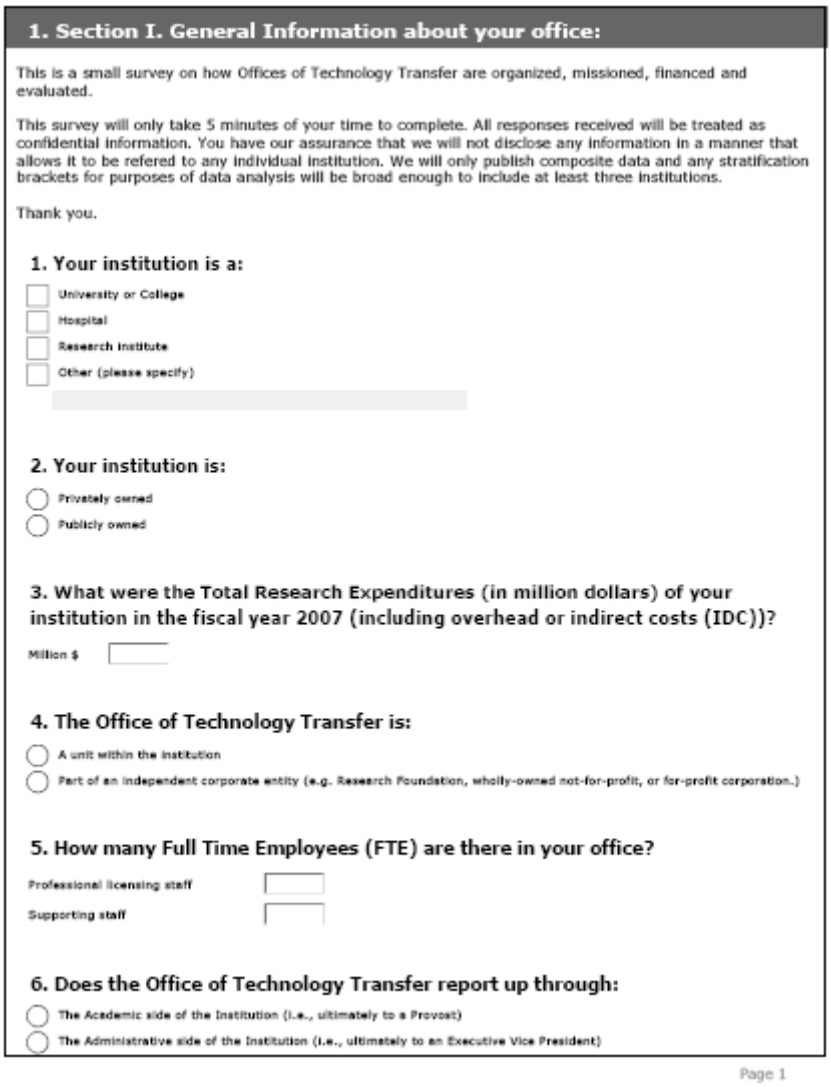
Appendix

Questionnaire



1. Section I. General Information about your office:

This is a small survey on how Offices of Technology Transfer are organized, missioned, financed and evaluated.

This survey will only take 5 minutes of your time to complete. All responses received will be treated as confidential information. You have our assurance that we will not disclose any information in a manner that allows it to be refered to any individual institution. We will only publish composite data and any stratification brackets for purposes of data analysis will be broad enough to include at least three institutions.

Thank you.

1. Your institution is a:

- ☐ University or College
- ☐ Hospital
- ☐ Research Institute
- ☐ Other (please specify)

2. Your institution is:

- ◯ Privately owned
- ◯ Publicly owned

3. What were the Total Research Expenditures (in million dollars) of your institution in the fiscal year 2007 (including overhead or indirect costs (IDC))?

Million $

4. The Office of Technology Transfer is:

- ◯ A unit within the institution
- ◯ Part of an independent corporate entity (e.g. Research Foundation, wholly-owned not-for-profit, or for-profit corporation.)

5. How many Full Time Employees (FTE) are there in your office?

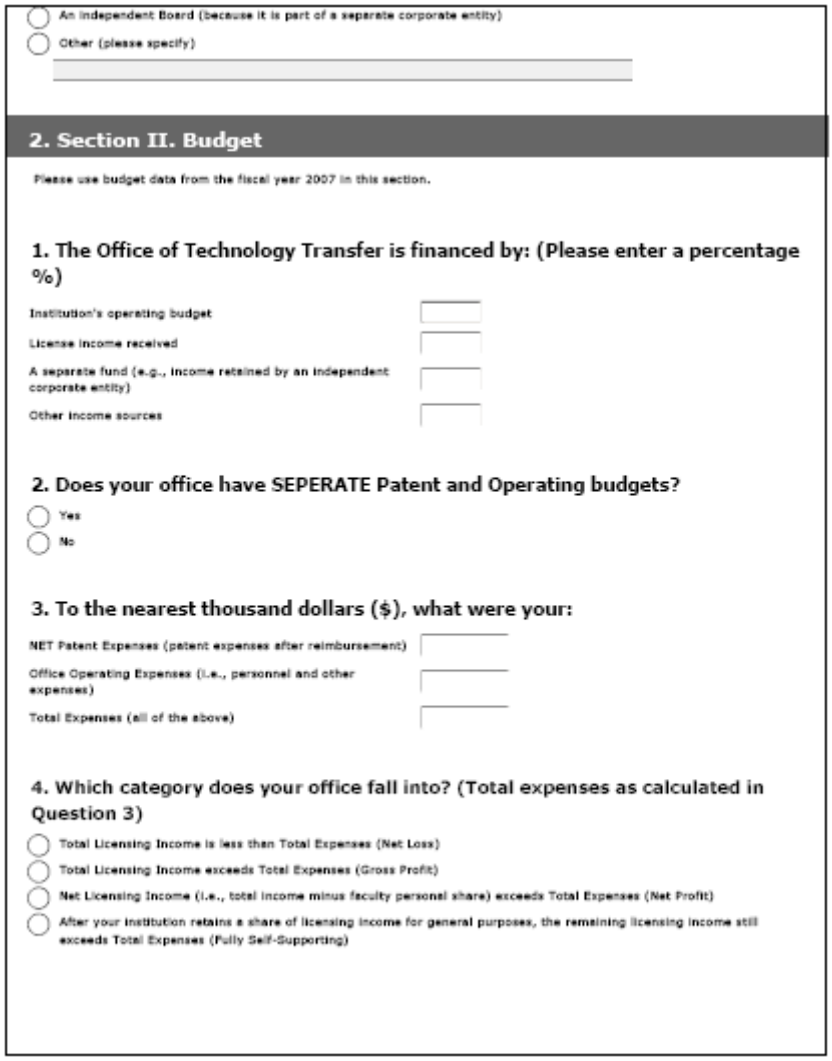
Professional licensing staff

Supporting staff

6. Does the Office of Technology Transfer report up through:

- ◯ The Academic side of the Institution (i.e., ultimately to a Provost)
- ◯ The Administrative side of the Institution (i.e., ultimately to an Executive Vice President)

Page 1



◯ An independent Board (because it is part of a separate corporate entity)
◯ Other (please specify)

2. Section II. Budget

Please use budget data from the fiscal year 2007 in this section.

1. The Office of Technology Transfer is financed by: (Please enter a percentage %)

Institution's operating budget	
License income received	
A separate fund (e.g., income retained by an independent corporate entity)	
Other income sources	

2. Does your office have SEPERATE Patent and Operating budgets?

◯ Yes
◯ No

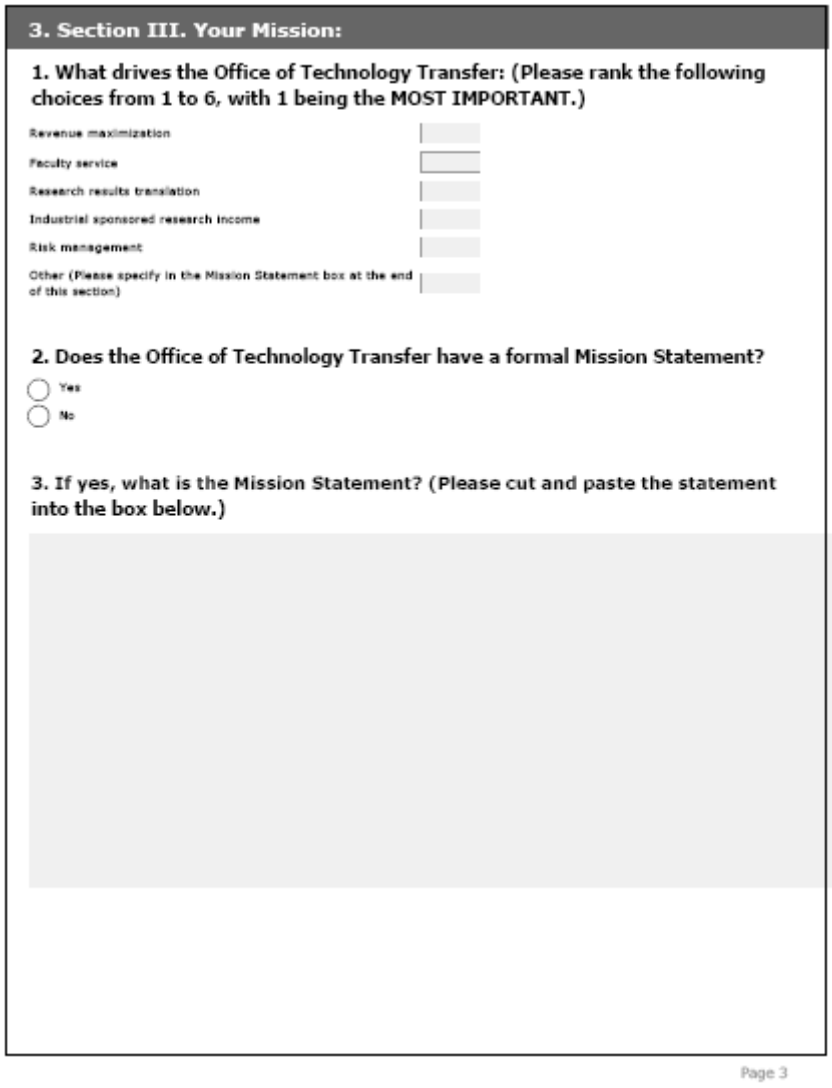
3. To the nearest thousand dollars ($), what were your:

NET Patent Expenses (patent expenses after reimbursement)	
Office Operating Expenses (i.e., personnel and other expenses)	
Total Expenses (all of the above)	

4. Which category does your office fall into? (Total expenses as calculated in Question 3)

◯ Total Licensing Income is less than Total Expenses (Net Loss)
◯ Total Licensing Income exceeds Total Expenses (Gross Profit)
◯ Net Licensing Income (i.e., total income minus faculty personal share) exceeds Total Expenses (Net Profit)
◯ After your institution retains a share of licensing income for general purposes, the remaining licensing income still exceeds Total Expenses (Fully Self-Supporting)

Page 2



3. Section III. Your Mission:

1. What drives the Office of Technology Transfer: (Please rank the following choices from 1 to 6, with 1 being the MOST IMPORTANT.)

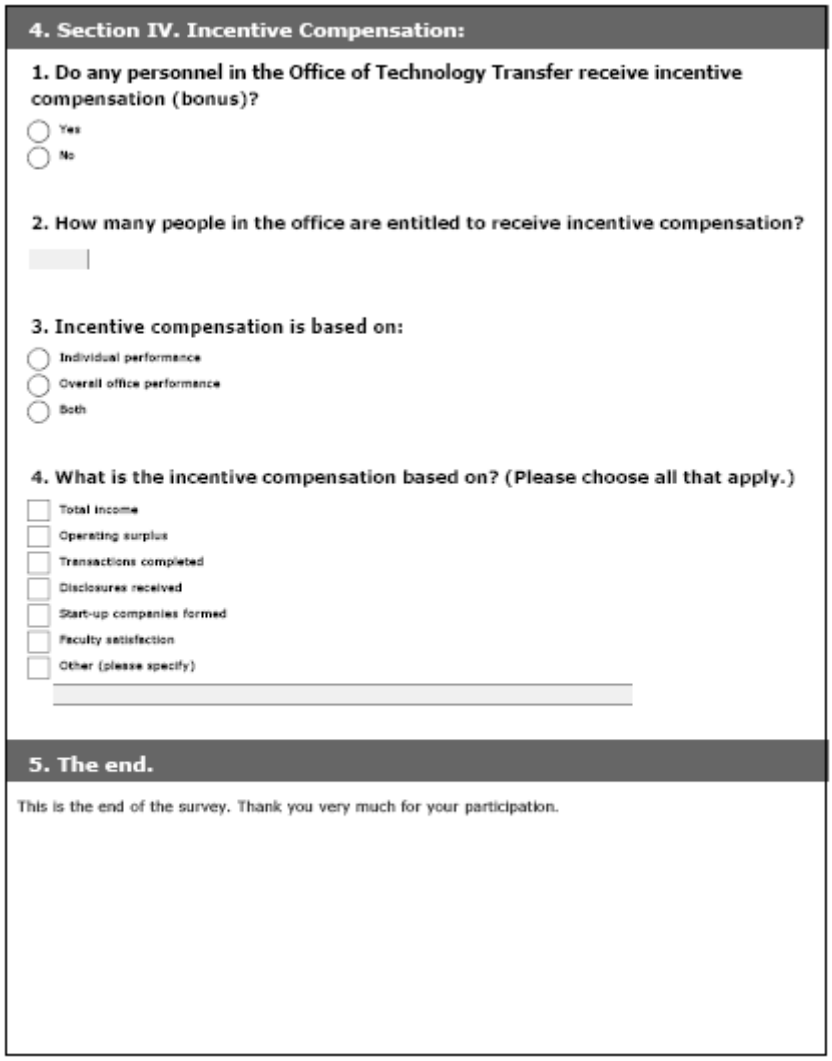
Revenue maximization	
Faculty service	
Research results translation	
Industrial sponsored research income	
Risk management	
Other (Please specify in the Mission Statement box at the end of this section)	

2. Does the Office of Technology Transfer have a formal Mission Statement?

- ◯ Yes
- ◯ No

3. If yes, what is the Mission Statement? (Please cut and paste the statement into the box below.)

Page 3



4. Section IV. Incentive Compensation:

1. Do any personnel in the Office of Technology Transfer receive incentive compensation (bonus)?

- ◯ Yes
- ◯ No

2. How many people in the office are entitled to receive incentive compensation?

3. Incentive compensation is based on:

- ◯ Individual performance
- ◯ Overall office performance
- ◯ Both

4. What is the incentive compensation based on? (Please choose all that apply.)

- ☐ Total income
- ☐ Operating surplus
- ☐ Transactions completed
- ☐ Disclosures received
- ☐ Start-up companies formed
- ☐ Faculty satisfaction
- ☐ Other (please specify)

5. The end.

This is the end of the survey. Thank you very much for your participation.

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ABOUT THE AUTHORS

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