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RMR

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The Journal of the National Council of University Research Administrators

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EDITOR'S PREFACE

Advances in science, engineering, and innovation during the last three decades have changed the way researchers approach their work, the methods and tools they use, the collaborative partnerships they develop, and the strategies they employ to keep their research programs supported throughout their careers. The administration of research has evolved alongside, to keep pace with the changing needs of researchers, institutions, sponsors, and the public, and this has led to a great diversification of the field.

Since becoming the *Research Management Review* Editor, I've heard from many readers—university administrators, state and federal agency program staff, industrial colleagues, post-doctoral fellows, faculty, and colleagues overseas, some of whom are not members of the NCURA—and all view the *RMR* as an important source of scholarly research and viewpoints about the administration of research. In recognition of the incredibly diverse research administration community that exists today, and our vast readership, the *RMR* recently expanded its focus and format, developed a Call for Articles and distributed it worldwide (http://www.ncura.edu/content/news/rmr/docs/CallforArticles.pdf). This issue is a reflection of some of this great diversity.

Part of the NCURA's core mission is to advance the field of research administration through the sharing of knowledge. Since 1987, the *RMR* has been an important vehicle by which the NCURA has fulfilled this part of its mission. It is my hope that as I follow in the footsteps of *RMR*'s most recent Editor, Dr. William Sharp, who stepped down after three years of outstanding leadership, and the Editors before him, that this journal will remain relevant and thought-provoking, reflect the great diversity of vocation and opinion that exists in our readership, and continue to move the field forward.

PAMELA PLOTKIN, Ph.D.
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AUGUST 2009

The Economics of University Research and Technology Transfer

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ABSTRACT

This paper presents an empirical analysis of university research and technology transfer activities. The small size of university research expenditures relative to the total R&D budget in the economy suggests that universities play a relatively minor role in applied research. By all indications, university technology transfer is expanding rapidly; however, financial results continue to lag. Universities also play a role in the transfer of knowledge to industry through sponsorship of incubators and research parks. In the past fifty years, university research has been funded primarily by federal agencies and only a small percentage by industry. With the recent turmoil in the economy and resulting shift in the government's spending priorities, the heavy reliance on government funding makes university research operations vulnerable. To survive in the long run, university research operations have to diversify their funding sources to include a larger share from industry.

INTRODUCTION

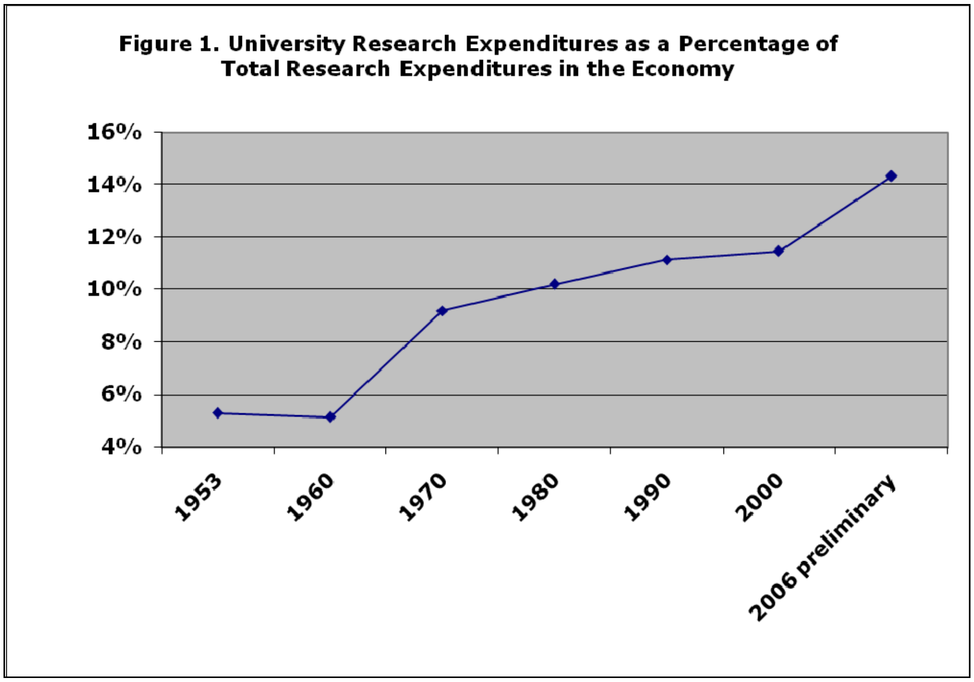
Following the passage of the Bayh-Dole Act in 1980, universities across the United States began to explore commercial opportunities in their inventions. Some found the business side of technology transfer incompatible with the tradition of academia. Others found insurmountable cultural disparity with corporate partners because the slow and deliberative process of the institution contrasted sharply with the rapid decision-making protocol of the business sector. Executing basic contracts on confidentiality, exclusivity, and royalty took a long time when universities demanded iron-clad provisions unacceptable to the corporate sector. A glimpse of such clashes is seen after the passage of the Bayh-Dole Act when corporate support for university research initially more than doubled but quickly tapered off[1], leaving disappointed corporate entities that swore off working with the academic institutions that distrusted them.

For a large number of highly ranked research institutions, technology transfer in its most direct form remains further down on the list of priorities.[2] The Johns Hopkins University is one such example. It maintains a ranking of first or second in the nation in annual research expenditures but only 40th in its technology transfer enterprise.[3] In general, the size of research expenditures remains a poor predictor of the extent of technology transfer activities.

In the following sections, we explore the economic theory and related empirical evidence in university research and technology transfer. In the second section we investigate the structure of university research using data from the National Science Foundation (NSF). In the third and fourth sections we explore patterns of university patenting and licensing and the microeconomics of choice between licensing a new technology and forming a startup company around it. The fifth and sixth sections contain an empirical investigation of the determinants of university licensing and the relationship between university research and technology transfer. In the seventh and eighth sections we discuss the macroeconomic factors in setting up a startup company and the critical role of venture capital firms in financing the startups and recruiting professional managers to operate them. The ninth section covers knowledge flows from universities to industry through establishment of incubators and research parks; the conclusion may be found in the final section.

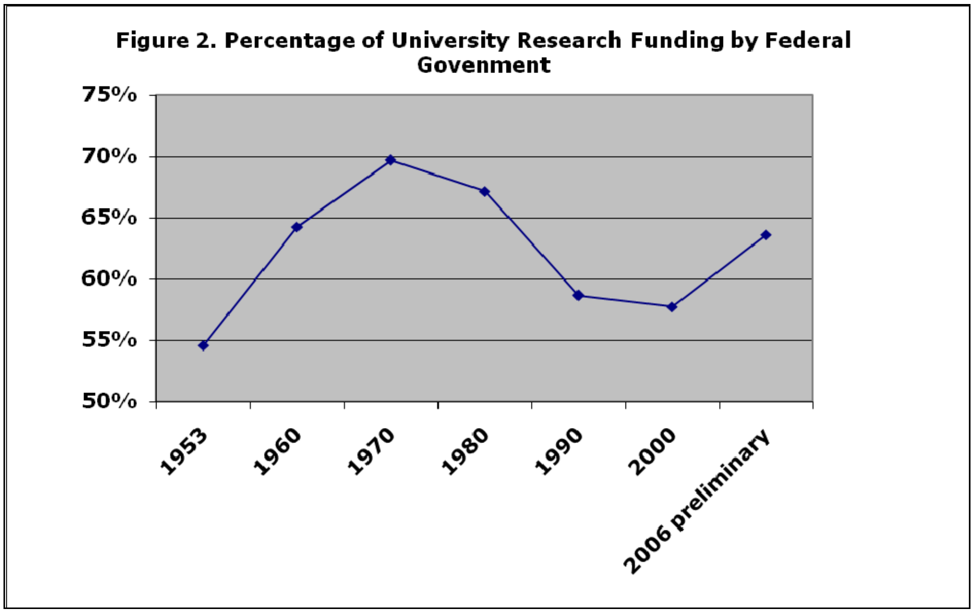
THE STRUCTURE OF UNIVERSITY RESEARCH FUNDING

A review of university research expenditures over the past 50 years suggests that the federal government has been the main source of research funding to both public and private universities. From 1953–2006, total research expenditures in the economy increased from $28 billion to almost $300 billion. During this period, university research expenditures grew by 6.5% each year from $1.5 billion to $43 billion.[4] The share of university research expenditures as a percentage of total research expenditures in the economy fluctuated from 6–14% (Figure 1). Industry remained the most active, with expenditures growing at 4.5% per year from $20 billion in 1953 (70.4% of total) to $211 billion in 2006 (70.5% of total).[5]



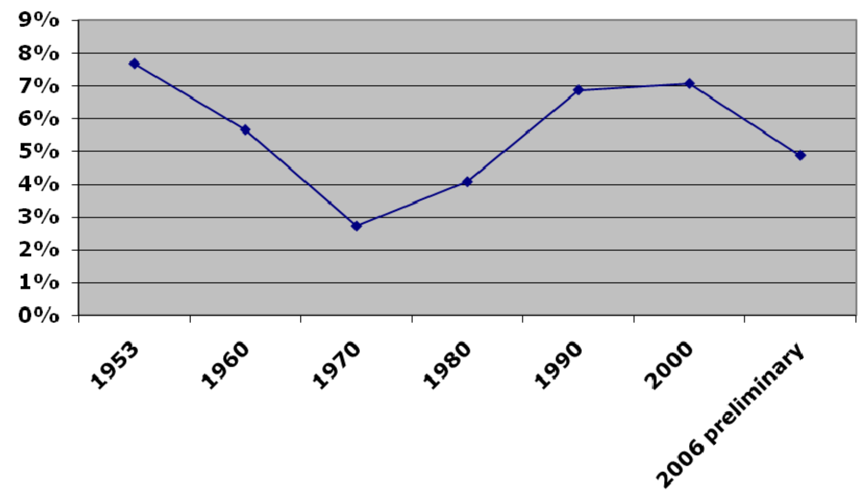
Data Source: National Science Foundation, *U.S. research expenditures, by performing sector and sources of funds: 1953–2006*

The share of federal government funds in university research funding ranged from 55% in 1953 to as high as 70% in 1970, declining to 64% by 2006 (Figure 2). Interestingly, the share of industry contributions to university research followed an opposite pattern. Starting at less than 8% in 1953 and falling to 3% in 1970, industry contributions increased steadily through the 1980s before stabilizing in the 1990s at 7% with a slight decline to 5% in 2006 (Figure 3). This suggests that universities behave proactively in seeking alternative sources of funding (e.g., industry) when the share of federal government funding is reduced.[6]



Data Source: National Science Foundation, *U.S. research expenditures, by performing sector and sources of funds: 1953–2006*

Figure 3. Percentage of University Research Support from Industry Sources



Data Source: National Science Foundation, *U.S. research expenditures, by performing sector and sources of funds: 1953–2006*

University research funding, financed primarily by the federal government, covers only a small fraction of total research in the economy.[7] With government expenditures at historic highs coupled with declining tax revenues due to economic and financial crises, there are no guarantees that federal funding for university research is going to grow. Unless university research contributions to the total economy are significantly increased and funding sources are materially diversified, there is a real chance the quality of university research will suffer in the next fifty years. The consequences of reduced government support for universities without alternative resources are starkly evident in France. Following the student uprising in 1968, the French government reduced its support for universities, causing a steady decline in the quality of research and education. Most French universities today hardly resemble their storied past. An important alternate funding source for university research is industry. Although there always have been collaborations between the two, the current level of collaboration is relatively small.

Obstacles to productive collaborations between corporate and academic sectors go beyond differences in cultures, although such disparity is a lingering problem. There also are structural issues that need to be addressed by universities. Historically, the most common academic research setting has been an individual laboratory assigned to a faculty member that is equipped with all of the necessary instruments. Beyond generalities, research conducted in one laboratory was often unknown to other laboratories and could be duplicating not only enormously expensive instruments and infrastructure, but also ideas at great cost. Movement from this perfectly controlled, albeit inefficient, environment to a more collaborative setting is taking place gradually with encouragement from granting agencies. “The scale and complexity of today's biomedical research problems increasingly demands that scientists move beyond the confines of their own discipline and explore new organizational models for team science.”[8]

To speed up the pace of collaboration, universities should increase the availability of shared laboratory and office space equipped with an array of instruments. Shared laboratories are centrally maintained, and their upkeep can be covered at least in part by the institution's indirect cost returns.

With shared facilities, investigators capable of performing substantive basic and applied research from multiple departments or colleges could be organized around multidisciplinary research platforms. As multidisciplinary centers grow on individual campuses, they could form material alliances with other centers in the region, state, or country, allowing them to share each other's technology and expertise. The expected gains from such coalitions would be enormous, considering significant potential savings from economies of scale (i.e., size) and scope (i.e., joint production). With vast resources and efficient processing, these coalitions would match the industrial sector in resources, opening up opportunities for meaningful collaborations between the two. At this stage of academic consortia-industry collaborations, research programs could proceed with significant funding from both the public sector and industry.

UNIVERSITY PATENTING AND LICENSING ACTIVITIES

The survey covers 154 universities. After deleting the observations with missing values, we ended up with 128 universities in our sample. Table 1 provides the basic statistics on the research and technology transfer activities of these institutions. The combined 2003–2005 research expenditures ranged in size from $25 million to $8.3 billion, with a mean of $749 million and median of $464 million.[10]

The number of startups per year ranged from 0 to 20, with a mean and median of 3 and 2, respectively. The number of licenses and options executed ranged from 0 to 265, with a mean and median of 27 and 16. The income from licenses also ranged widely, from no licensing revenues to more than $585 million. The number of full-time equivalent (FTE) licensing agents ranged from 0 to 63, with mean and median of 5 and 3, respectively.

Table 1. Basic Statistics

2003-2005 Cumulative Research Expenditures ($millions)		**Startups**	***Licenses & Options* Executed**	***Licensing Income* ($millions)**	***Licensing* FTE**
Mean	749.23	2.9	27.6	11.80	4.9
Standard Error	85.25	0.3	3.2	4.76	0.6
Median	464.45	2.0	16.0	1.52	3.0
Standard Deviation	964.45	3.5	36.5	53.80	6.4
Sample Variance	930163.02	12.0	1334.0	2894.62	41.2
Minimum	25.35	0.0	0.0	0.00	0.0
Maximum	8331.61	20.0	265.0	585.66	63.0

Data Source: AUTM, *Licensing Survey, FY2005*

STARTUPS VERSUS LICENSES

In commercializing a discovery, universities face two choices: license it to an existing company, or establish a startup company around the technology. Important distinctions in the nature of discovery dictate the optimal choice.

If a discovery provides improvements over an existing technology and complements other product lines, it would make economic sense to license it to an existing company.[11] The new product would be incrementally better than the previous one due to higher quality, lower price, or both. For the licensor, such an arrangement provides steady royalties and little downside risk. On the other hand, if a discovery leads to a radical new technology previously unknown and enough of a platform on which to create a new company, the optimal choice for commercialization would be to establish a startup company.[12] This is predicated by the fact that a new technology is risky by nature with no existing production and distribution channels and no information on the size of the market or pricing of the product. Consequently, established companies rarely take on such high-risk inventions, especially when they are not from their own laboratories.

Despite obstacles in producing and marketing a promising technology, startups may succeed and survive if their entry into the market could potentially force existing companies with inferior technologies out of the market. However, this would be a plausible scenario only if the technology belongs to a dispersed industry with little concentration and no clear leader. In heavily concentrated sectors, developing production and sales distribution channels may be cost prohibitive.[13]

A startup company with a promising technology in a less-concentrated sector could attract angel and venture capital funds to produce and market the new technology. As the startup continues work on the new technology and successfully completes early stages of its development, established companies become interested in acquiring the startup. Alternatively, the startup may go public with help from its venture capital backers.

The FY2005 AUTM survey provides no information on the nature of the discoveries, thereby making a direct test of hypotheses based on the above discussion impossible. However, we could examine factors that affect the choice between establishing a startup, which presumably is based on the likelihood of its survival, and licensing outright to an established firm. This exercise would allow us to make inferences about the survivability of startups around new technologies.

To empirically test our contention, we use a multivariate regression model generally stated as:

$$Y_{ij} = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots\ldots.. + \beta_j X_{ij} + \varepsilon_{ij}.$$

Here, Y_{ij} represents a vector of dependent variables proxied by the annual number of startup companies established by a university, and X_{ij} represents a vector of independent variables including the number of licensing agents employed at the technology transfer office, number of U.S. patents issued annually, and amount of external research funding that explains changes in the dependent variables. β_0 is the intercept vector, and β_j is the coefficient vector for the independent variables.

Table 2 presents results of the regression analysis. The adjusted R-square is 59%, suggesting that the independent variable set explains 59% of the variability in the number of startups established. The F test for ANOVA (analysis of variance) indicates significant differences among universities when it comes to the number of startups they form (the null hypothesis is rejected).

Table 2. Regression Analysis with Dependent Variable = Number of Startups

Regression Statistics						
Multiple R	0.77494					
R Square	0.60053					
Adjusted R Square	0.59087					
Standard Error	2.2193					
Observations	128					
ANOVA						
	df	***SS***	***MS***	***F***	***Significance F***	
Regression	3	918.136	306.045	62.1372	1.3639E-24	
Residual	124	610.739	4.92531			
Total	127	1528.88				
	Coefficients	***Standard Error***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***
Intercept	1.39463	0.25444	5.48113	2.3E-07	0.89101944	1.89825
Licensing FTE	-0.1459	0.07482	-1.94935	0.05351	-0.2939568	0.00224
U.S. Patents Issued	0.07505	0.01128	6.65638	8.1E-10	0.05273588	0.09737
2003–2005 Research Expenditures	0.00101	0.00053	1.89971	0.05979	-4.25E-05	0.00207

Data Source: AUTM, *Licensing Survey FY2005*

Among independent variables, the coefficient for the number of U.S. patents issued is positive and highly significant, meaning that an active patent portfolio often leads to the establishment of more startups. The coefficient for research expenditures is also positive and significant, suggesting that, on average, a large number of startups come out of highly funded research institutions. This, of course, does not mean that a university with significant research funding would automatically end up forming more startups.

The coefficient for the number of licensing agents is negative and significant. It is interesting that universities with a greater number of licensing agents end up licensing more of their inventions than setting up startups.

DETERMINANTS OF UNIVERSITY LICENSING ACTIVITY

We set up a regression model to investigate factors that affect the level of licenses and options executed by a group of independent variables, including the number of licensing agents, to study the impact of staffing levels on licensing outcome; cumulative research expenditures to proxy for the size of the research enterprise affecting the invention portfolio; and licensing income to test whether active licenses generate significant income. Although licenses and options signed in one year are likely to be a function of our independent variables in other years, we have used the same period for all, assuming that their magnitudes are highly correlated over time.

Table 3 presents the results. The adjusted R-square is 66%, suggesting that this group of independent variables explain 66% of the variability in the number of licenses and options executed by universities. As expected, the coefficient for the number of licensing agents is positive and highly significant, suggesting that staffing levels impact licensing activities. The coefficient for cumulative research expenditures is also positive and significant, suggesting that, on average, high levels of licensing activity are associated with large research expenditures. Interestingly, the coefficient for licensing income shows no significance, supporting the anecdotal evidence that large quantities of licenses and options signed do not automatically lead to large amounts of licensing income. Conversely, small numbers of licenses and options executed do not necessarily mean lower income. In fact, there is anecdotal evidence to suggest that universities may have differing strategies when it comes to the number of licensing contracts they sign. Some form extensive portfolios with a large number of low-paying licenses, while others focus on a few “big hits”.

Table 3. Regression Analysis—Dependent Variable = Licenses and Options Executed

Regression Statistics						
Multiple R	0.817001					
R Square	0.667491					
Adjusted R Square	0.659446					
Standard Error	21.31446					
Observations	128					
ANOVA						
	df	***SS***	***MS***	***F***	***Significance F***	
Regression	3	113086.701	37695.6	82.9739	1.6483E-29	
Residual	124	56333.9786	454.306			
Total	127	169420.68				
	Coefficients	***Standard Error***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***
Intercept	4.054414	2.40721767	1.68427	0.09464	-0.71014437	8.818972
Licensing FTE	2.293796	0.69789989	3.28671	0.00132	0.91245697	3.675136
20 03-2005 Research Expenditures	0.016439	0.0046254	3.554	0.00054	0.00728372	0.025594

Data Source: AUTM, *Licensing Survey FY2005*

RELATIONSHIP BETWEEN RESEARCH ACTIVITY AND TECHNOLOGY TRANSFER

One would expect more technology transfer activity at universities with large research expenditures because basic research can lead to discoveries that are ultimately commercialized. Exceptions aside, we examined whether, on average, there is a relationship between research funding and the scale and scope of technology transfer activities.

To investigate this relationship, we set up a regression model with research expenditures serving as the dependent variable and number of startups established, number of licenses and options executed, amount of licensing income earned, number of licensing agents employed, and number of U.S. patents issued as independent variables. We claimed no direction for causality in our model and limited our inquiry to whether there is a relationship, regardless of the direction, between research expenditures and level of technology transfer activities.

Table 4 presents the results. The adjusted R square for the model is 86%; along with the results from the ANOVA table, we can safely say that there is a material relationship between research expenditures and certain proxies for technology transfer. Coefficients for licenses and options, number of licensing agents and U.S. patents are all significant and positive, suggesting that universities with large research expenditures are often more active in these areas. Coefficients for startups and licensing income are not significant.

Table 4. Regression Analysis: Dependent Variable = Total Research Expenditures

Regression Statistics						
Multiple R	0.93001					
R Square	0.86493					
Adjusted R Square	0.85939					
Standard Error	361.65					
Observations	128					
ANOVA						
	df	***SS***	***MS***	***F***	***Significance F***	
Regression	5	1E+08	2E+07	156.241	2.8E-51	
Residual	122	1.6E+07	130791			
Total	127	1.2E+08				
	Coefficients	***Standard Error***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***
Intercept	56.9022	45.9375	1.23869	0.21784	-34.036	147.84
Startups	16.1965	15.1979	1.06571	0.28866	-13.889	46.2823
Licenses & Options Executed	3.87611	1.54818	2.50365	0.01361	0.81132	6.94089
License Income in Millions	0.02227	0.61104	0.03644	0.97099	-1.1874	1.23189
Licensing FTE	81.8935	10.8155	7.5719	7.8E-12	60.4833	103.304
U.S. Patents Issued	7.00696	2.06134	3.39922	0.00091	2.92633	11.0876

Data Source: AUTM, *Licensing Survey FY2005*

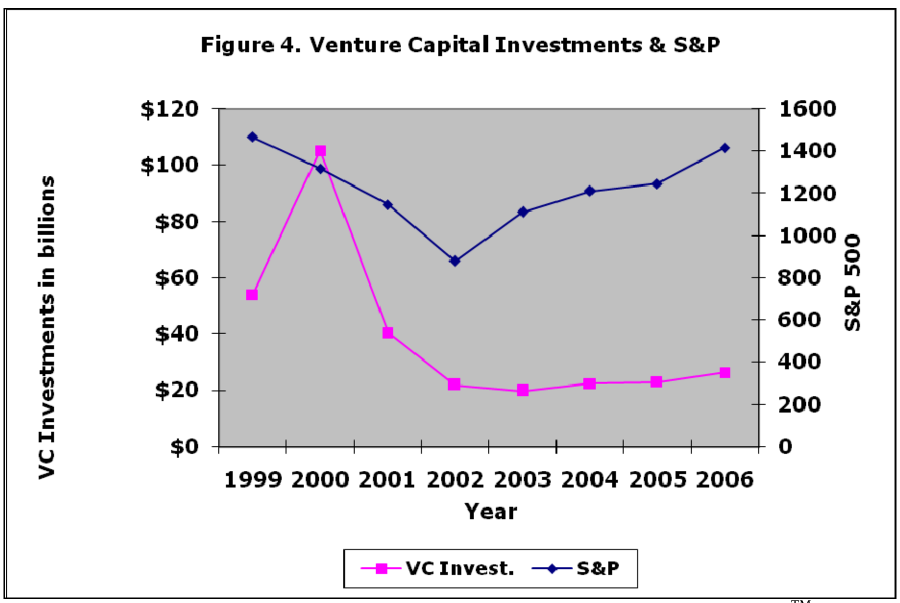
Combined, these results suggest that, on average, universities with large research expenditures tend to license their technologies more often than using them to form startup companies.[14] The results further suggest that large numbers of licenses and options do not necessarily lead to large amounts of licensing income. This is consistent with the anecdotal evidence that the vast majority of university technology licenses produce relatively little or no income at all. Those with significant licensing income often succeed in one major discovery that leads to significant income over multiple years.

MACROECONOMIC FACTORS AND STARTUP STRATEGY

In the fourth section we discussed the economics of setting up a startup company from the perspective of a university, suggesting that new high-risk technologies that lead to previously unavailable products may be used to establish a startup company, holding the impact of market forces constant. We address the issue of macroeconomic impact in this section.

In the early stages of development, startup companies often need significant funding from the venture capital community. The flow of venture funding is directly related to market conditions. For example, in the late 1990s and early 2000s when the stock market was at historic highs, there also was an active market for initial public offering (IPO). The prospect of taking a startup company public and divesting its investment in a timely fashion encouraged venture capital firms to invest in many deals. At their peak in 2000, venture capital firms invested $105 billion in startups. As the market cooled shortly thereafter and the number of IPO cases declined drastically, so did the level of venture capital investments and the number of startup formations. The credit situation improved in the following years until late 2008 when a confluence of events created a serious credit crunch not only in the United States but also across the world. Although data are not currently available, the 2008 financial crisis will undoubtedly have an adverse impact on the availability of capital for startup formation.

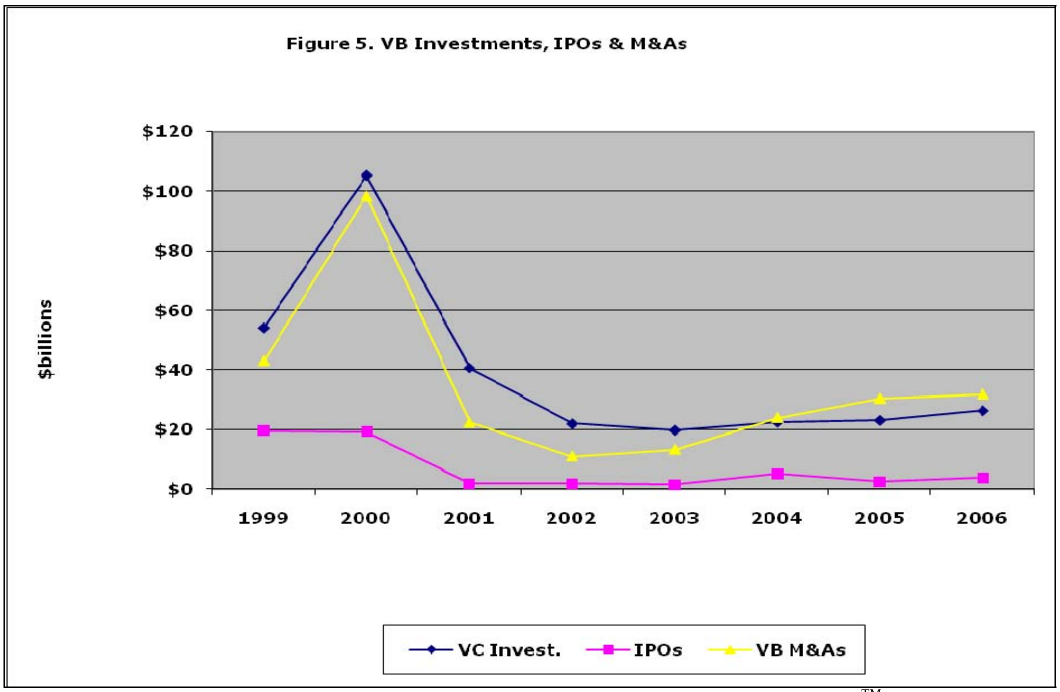
Figure 4 charts the level of venture investment and the S&P 500 index. There is a close relationship between the highs and lows of the market and the level of venture capital investments. When the stock market performs well, the market is more hospitable toward venture-backed IPOs. With prospects for a healthy IPO market, venture capital firms are more willing to make deals for startups.



Data Source: PricewaterhouseCoopers/Thomson Venture Economics/NVCA MoneyTree™ Survey

An alternative to taking a startup public is to sell it to an existing company through mergers and acquisitions (M&As). As a startup reaches later stages of development with a clearer picture of commercial potential for its products, there is less uncertainty, and existing firms become more interested in acquiring the startup. Alternatively, a venture capital firm may want to exit from its investment in the M&A market where an established firm purchases the startup. When markets for IPOs and M&As are active and healthy, venture capital firms have clear avenues to exit from their investments.

Figure 5 presents a match-up of venture capital investments and dollars raised through venture-backed IPOs and M&As. There is a clear parallel in the dollar value of venture investments with the size of venture-backed IPO deals and venture-backed M&As. Figure 6 presents additional evidence by charting the amounts of venture investment with the number of startup deals executed. Again, there is a clear interdependent relationship between the two.



Data Source: PricewaterhouseCoopers/Thomson Venture Economics/NVCA MoneyTree™ Survey

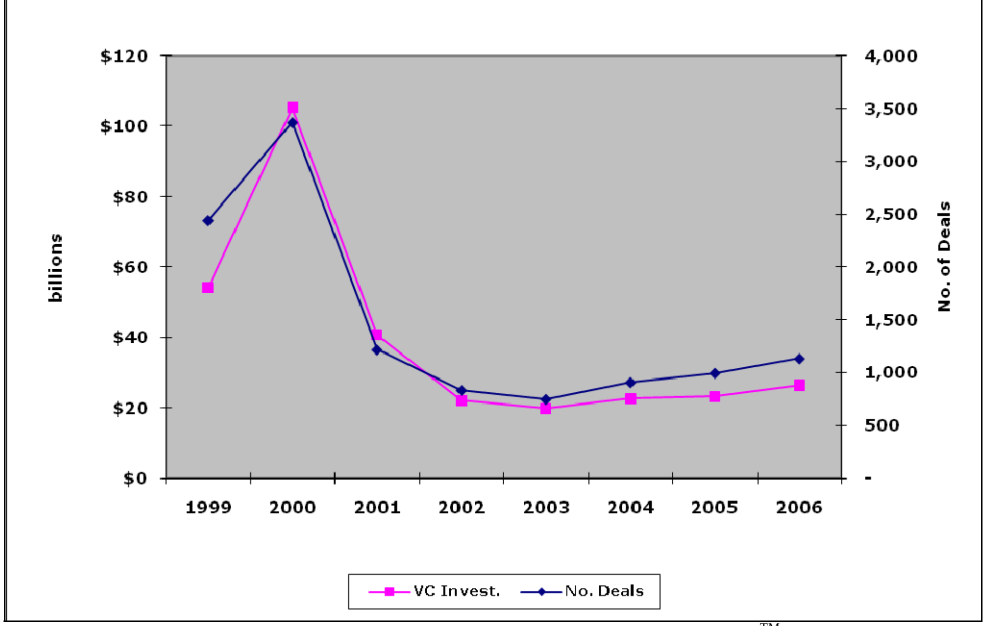


Figure 6. Venture Capital Investments & No. of Startup Deals

Source: PricewaterhouseCoopers/Thomson Venture Economics/NVCA MoneyTree™ Survey

Combined, IPOs and M&As serve as the demand factor for venture assets, while investments in startups form the supply side. We contend that demand dictates supply and choice between establishing a startup company and licensing the technology to an existing entity is affected strongly by macroeconomic factors in addition to internal variables.

VENTURE CAPITAL VALUE PROPOSITION BEYOND FINANCING

In the earlier sections, we discussed the important role venture capitalists play in providing financial support for startup development. Clearly, the data show that macroeconomic factors play a major role through venture capital firms in the operation and survivability of the startups. An active equity market and the prospects of timely exit through IPOs or M&As enable the venture capitalists to engage in extensive deal-making with startups. In addition to their role as financiers, venture capital firms play an even broader and perhaps more critical role in startup management and survivability. To explore this additional function, we first examine a venture capital firm in the context of the economic theory of the "firm" and then its role as a "financial intermediary."

There is an extensive discussion in the financial economics literature on the notion of the "firm." The literature posits that formation of a firm is economically justified on the grounds that it creates a value-added benefit otherwise unattainable. Accordingly, a firm is defined as a nexus of contracts among investors (i.e., equity holders, bondholders, etc.) who supply the resources to acquire raw material and labor, managers who oversee the production of the output, and other stakeholders (i.e., supplier of inventory, customers of the products, etc.) toward the goal of producing certain goods or services. Since the interests of various stakeholders vary, conflicts of interest and ways to resolve them become important reasons why and how a firm is established and whether it is going to survive. For a firm to survive, it has to be economically efficient and capable of mitigating the inherent incentive problems at least as well as its competitors. Otherwise, it would be at a cost disadvantage and unable to survive in the long run.[15]

Similarly, in dealing with a startup company, one has to be cognizant of potential incentive conflicts among founders, who contribute the intellectual core of the business; financiers, who supply the capital; managers, who run the day-to-day operation; and other stakeholders, who come together with differing expectations. At the core, potential conflicts are due to the opaqueness of the business itself. Founders, who clearly understand the technology, often lack sufficient insights into production, sales, and other professional matters required to run a successful business. Early investors and other such stakeholders simply do not know all of the details of the technology and its prospects. And professional managers, who are recruited to handle the business side of the operation, are often uncertain whether they can make decisions based on business principles or must obtain founders' approval every step of the way.

Uncertainty engenders risk, and risk hinders the development of the firm and ultimately its value. Venture capital firms can play a crucial role in resolving the uncertainties. To understand this role, let's look at the theoretical underpinnings for financial intermediaries as a special case of firms that also include venture capitalists.

As the name suggests, financial intermediaries (e.g., commercial and investment banks, brokerage houses, insurance companies and venture capital firms, among others), stand between individual lenders, who would like to invest in an enterprise with promising returns but are reluctant to do so because of significant information disparity, and ultimate borrowers, who intentionally or unintentionally keep the details of their businesses secret. Enter financial intermediaries that could, on behalf of the investors, perform all of the necessary due diligence through extensive information-gathering, sorting, and analysis before making an investment decision. So goes the modern theory of financial intermediation that assigns a unique role to the intermediaries due to their ability to produce the necessary information and mitigate the information asymmetry problem between ultimate borrowers and lenders.[16]

This unique role allows the intermediaries to collect non-public information about the borrowers (i.e., startups) and keep it confidential. It is the promise of confidentiality that convinces the startup to voluntarily release its technology secrets in return for a substantial investment by the intermediary. Since the intermediary becomes an equity holder or "residual claimant," the interests of the startup founders and the intermediaries are aligned such that both would profit if trade secrets are kept from competitors over the period of time necessary for development of the technology and building of the infrastructure before entering the market. As financial intermediaries, venture capital firms engage in confidential information-gathering and processing about a startup before making an investment decision.

In addition, venture capital firms may go further than any other intermediaries by exerting varying levels of influence in the day-to-day operations of a startup. This unique role among intermediaries is afforded to venture capital firms because, unlike other intermediaries that provide loans but remain outside the firm (e.g., commercial banks), venture capital firms often become active in the management of the startup in varying degrees, from joining the board to helping to establish a professional management team.

Venture capital firms play either a "soft role" or a "hard role" in dealing with the management of a startup. The former entails steps that are considered "accommodating" to founders, whereas the latter is characterized as "separating."[17] An example of such an intervention is seen in hiring outside CEOs. On occasion, founders agree to change their role and remain in the firm as CTO or VP for Development. These cases are indicative of a "soft role" that venture capital firms play. You may also see this in cases in which founders decide to move to other projects outside the startup but remain on the board. When a new CEO is recruited and thereafter the founders break all connections to the company, it is highly likely that the venture capital role in the changeover is of the "hard" kind. In a survey of 91 turnovers in Silicon Valley startups, 38 cases (40%) were reported as soft and accommodating.[18] If this is the trend, one could conclude that changeovers are often accompanied by separation from original founders and the startup.

In addition to their role in hiring CEOs, venture capital firms often put in place professional management teams that also take care of production, sales, marketing and human resources functions. Such interventions, by all accounts, are positive and help the survivability of the startups.

UNIVERSITY KNOWLEDGE FLOW AND THE ECONOMICS OF UNIVERSITY-BACKED INCUBATORS

In this section, we go beyond the mere size of university research expenditures as a gauge of its significance and explore other, albeit indirect, avenues through which universities contribute to the economy. One such category of contributions includes university-backed incubators and research parks. By all accounts, these entities provide unique contributions to the economy but their significance has been difficult to measure beyond anecdotes.

A related issue is the impact of university research on total research in the economy. University research results are extensively, freely, and publicly disseminated through publications, conferences, consulting contracts, joint ventures, and patents. Access to such extensive sources of advanced information is vital for industry research.

Early research in this field, especially that focusing on the overall impact of university research on industry, uniformly supports the view that universities play a crucial role in the success of industry research. For example, studies have shown that academic research, measured by publications, contributed to 18 of 20 two-digit U.S. manufacturing industries over a 40-year period beginning in 1943.[19] Others have shown that university research has made significant contributions to future generations of industrial patents.[20]

Two influential surveys—the 1983 Yale Survey and 1994 Carnegie Mellon Survey of R&D managers—inquired about the relevance of university research for technical progress in industry. The results strongly supported the notion that university research has had a major impact on the scientific development of the industry, especially in the drug, chemical, and electronics fields.[21]

University-backed incubators provide an opportunity to directly test knowledge flows from university research to incubator companies. A study investigated whether knowledge flows enhance incubator firm performance using firm-level data for 79 companies incubated between 1998 and 2003 in the Advanced Technology Development Center, an incubator sponsored by the Georgia Institute of Technology.[22] University knowledge flows were identified through licenses to the resident companies, company patent citations of university research, and research by the incubator-sponsoring university and non-sponsoring universities. The study gauged incubator-resident performance by company revenues, total external funding, and venture capital investments, and whether the company graduated from the incubator in a timely manner. The results revealed no significance for the revenue variable (most likely due to age of the firm), but a positive correlation between university knowledge flows and other aspects of performance such as venture capital investments and timely graduation. Interestingly, holding sponsoring-university licenses did not affect resident performance per se, suggesting that once an incubator is set up, it really does not matter whether companies that reside in the facilities are spin-offs from the sponsoring university or non-sponsoring universities.

With more than 4,500 incubators worldwide, including 1,500 university-sponsored operations, startup companies and their natural habitats, incubators, have become important players in the business of commercializing discoveries. Add the impact of university research parks, which house medium and large companies, and universities play a major role in the commercialization of new discoveries and in economic development.[23] This impact is disproportionate to the relative small size of university research expenditures. Finally, studies show that proximity to a university is a good predictor of an incubator, resident company, and research park performance.[24] Despite advances in telecommunication technology, which is supposed to make geography and distance less relevant in conducting research or attending the business of an enterprise, proximity to university researchers and other expertise on campus is a crucial factor in the performance of incubator startup companies and research parks.

CONCLUSION

This paper is a data-driven inquiry into the current status and future direction of university research and technology transfer. Our results show that university research expenditures, funded primarily by federal agencies, constitute a small fraction of the total R&D budget in the economy. Furthermore, the percentage of university research funded by industry is in the single digits. However, this does not negate the fact that the flow of basic research knowledge to industry remains high. Our results further indicate that technology transfer activities have grown unevenly across universities. Interestingly, the size of research expenditures turns out to be a necessary but insufficient condition for the level of tech transfer activities; and the size of licensing revenues does not seem to correlate with the number of licenses and options issued. University-sponsored incubators and research parks contribute significantly to the success of startup companies by virtue of the flow of new knowledge through licensing and other forms of collaborations. Recent turmoil in the economy has put university research and related technology transfer activities at risk. To survive in the long run, university research operations have to diversify their funding sources to include a larger share from industry.

ENDNOTES

1. National Science Foundation, *U.S. Research and Development Expenditures*, various issues.

2. In addition to direct transfer of technology, there are other ways to get the results of research out to the public domain. For example, publishing research results helps corporate R&D departments in developing commercial products.

3. This ranking may change as Johns Hopkins moves aggressively into the technology transfer field assisted by its new Carey Business School opened on January 1, 2007.

4. National Science Foundation, *U.S. Research and Development Expenditures*, various issues.

5. All in 2000 constant dollars.

6. Other sources of research funding for universities include state governments and not-for-profit foundations.

7. When we compare university and industry research, our focus is on applied research. Historically, universities have been minor players in applied research while focusing primarily on basic research. The contribution of basic research to industrial R&D is significant.

8. NIH, *Roadmap for Medical Research*.

9. Association of University Technology Managers (AUTM), *U.S. Licensing Survey: FY 2005*.

10. The $8.3 billion figure was for the University of California System. Johns Hopkins, with $4.73 billion, was the largest single university. See http://www.autm.net/pdfs/AUTM_LS_05_US.pdf.

11. In concentrated industries existing firms often have extensive sales and distribution channels unavailable to a new startup. In these cases, there is a compelling argument for licensing. See Teece (1986). For a broader argument on concentrated industries requiring large sums of asset-specific investments in production and marketing channels, see Williamson (1985).

12. Prior research in this area is extensive. Most focus on the survivability of startup companies. To the extent survivability depends on the same set of factors that dictate the choice of organizing a startup instead of licensing the IP, its outcome could be parallel to ours. See, for example, Tushman and Anderson (1986), Henderson (1993), Lerner (1994), Utterback (1994) and Christensen and Bower (1996). A more direct argument linking survivability to exploitation of radical technologies with broad scope patents is made by Shane (2001).

13. For a theoretical and empirical implication of this argument, see Nerkar and Shane (2003).

14. Another explanation could be that in some cases universities do not directly get involved in forming companies; instead, the entrepreneurial faculty initiate forming startups and then request tech transfer offices to license the intellectual property to such companies.

15. Coase (1937) discussed the firm and many economic issues surrounding its optimal structure. Later, Jensen and Meckling (1976) and Williamson (1985) expanded on the topic. For a detailed survey of the field, especially in the context of financial firms, see Arshadi and Karels (1997), “Why Do Firms Exist?” (chapter 2).

16. For a survey of the unique role for financial intermediaries, see Arshadi and Karels (1997), “Why Do Financial Intermediaries Exist?” (chapter 3).

17. Hellmann and Puri (2002) use these terms to differentiate between an intervention that is welcomed by the founders, therefore termed "soft," and the kind considered coercive, which is termed "hard."

18. Hellmann and Puri (2002).

19. See Adams (1990). There was, however, a major lag time up to ten years for applied sciences and engineering and up to twenty years for basic science publications.

20. Jaffe (1979).

21. See Klevorick et al. (1994) and Cohen et al. (1998).

22. See Rothaermel and Thursby (2005).

23. As an example, UM-St. Louis, a Carnegie-classified "high research activity" institution, is the founder of two incubators (Center for Emerging Technologies and IT Enterprises) and a research park. The two incubators combined provide 150,000 square feet of space to startups in biotech and IT. The research park sits on approximately 100 acres of land with Express Scripts, Inc., a Fortune 150 company, as its anchor tenant.

24. Link and Scott (2004).

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Understanding Barriers and Supports to Proposal Writing as Perceived by Female Associate Professors: Achieving Promotion to Professor

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ABSTRACT

Research administrators play many roles in higher education institutions. One of those roles involves encouraging and assisting faculty in the development of proposals for external funds. Becoming familiar with the barriers faced by faculty as they work to develop proposals is an important part of any research administrator's work. This article describes research conducted on the barriers and supports perceived by female associate professors at three state universities in Idaho as these faculty write proposals for external funds. Female associate professors are the focus of this article because recent research has shown that women do not progress to the rank of professor as quickly or as often as men do. After a review of the research, suggested solutions are presented to help female associate professors increase the number of proposals they write, and in turn, possibly increase their chances of achieving promotion.

INTRODUCTION

In 2005 several faculty and staff at Idaho State University (ISU) began work on a proposal to the National Science Foundation (NSF) ADVANCE program. The ADVANCE program seeks to "develop systemic approaches to increase the representation and advancement of women in academic science and engineering careers, thereby contributing to the development of a more diverse science and engineering workforce" (NSF, n.d.). The culture and climate of ISU were examined to determine what focus the ADVANCE grant should take to best accommodate the advancement of female faculty at the university. It became evident that women at ISU were achieving tenure and promotion to associate professor, but often either left ISU before reaching the rank of professor or did not go up for promotion to that rank, frequently staying at the associate professor level for most of their career.

Beginning with a review of the literature, this article considers the phenomenon of female faculty lagging behind male faculty in terms of reaching the rank of professor, not only at ISU but across the United States at degree-granting universities (Conley & Leslie, 2002). The literature reveals that the number of grant proposals submitted by faculty for external funds can be one facet of the academic rank promotion process. As such, this article describes research conducted by the authors, examining barriers and supports perceived by women faculty as they write proposals for external grant funds. This research could provide insight into some of the issues that hold women back, as well as those that can support them in their journey to the rank of full professor.

This research is important to research administrators as they assist and advocate for faculty. Pogatshnik (2008) wrote that research administrators must acknowledge “the duties, responsibilities and hurdles faced by…faculty colleagues” (p. 12) as they write proposals for external funds. When writing about research administrators’ work with faculty, Robinson (2008) stated, “However, when these two factions actually start communicating and understanding each other’s goals and issues, the resulting collaboration inevitably leads to significant improvements for everybody” (p. 40). Research, such as that described in this article, has the potential to assist research administrators in understanding hurdles faced by faculty.

RELATED LITERATURE

Increasingly since the 1960s, relaxed societal norms and values have opened the college experience to women (Nidiffer & Bashaw, 2001). Females now make up a higher percentage of students who earn an undergraduate degree. In 2001, 56% of college undergraduates were female (Hudson, Aquilino, & Kienzi, 2005). In 2004–2005, women received just under 60% of bachelor’s and master’s degrees (*Chronicle of Higher Education*, 2007).

Just as the number of female higher education students has increased, so has the number of female faculty (Nidiffer & Bashaw, 2001). Increasingly, women have earned advanced degrees, qualifying them to teach in institutions of higher education, and as more female students have entered college, women have been hired in staff and faculty positions to oversee and instruct female students (Nidiffer & Bashaw, 2001). Despite these gains, a difference in the numbers of men and women working as faculty in academia persists. More often, female faculty members are concentrated at master’s-, baccalaureate-, and associate-level institutions. In 2003, the only field that had more female than male faculty was education. Women as faculty are more prevalent at church-related institutions and are more often found in the lower academic ranks (i.e., instructors and assistant professors) (AAUP, 2004). These demographics show that, in general, there are sex-based differences in terms of faculty numbers, rank, and institution affiliation. Table 1 offers several comparisons of female versus male students and faculty in higher education.

Table 1. Comparison of Significant Issues in Higher Education, Based on Gender

Issue	Women	Men
Number of students enrolled in higher education, fall 2002	57%	43%
Number of students graduating with bachelor's degree, 2003	57%	43%
Number students enrolled in higher education since 1981	54%	46%
Full-time faculty, fall 2003	38%	62%
Faculty with spouse in academia	49%	12%
Full professors, 2003	24%	76%
Assistant professors, 2003	45%	55%

Women do not advance in faculty rank as quickly, if at all, from associate professor to professor as men do. According to the National Center for Education Statistics (NCES; 2000), in 1997, 16% of female faculty at degree-granting institutions had attained the rank of professor; in 2005, 15% of female faculty were professors (i.e., a relative decrease over the 8-year period). White (2005) examined the status of women at several research universities and found that the number of female professors had not increased from 2000 to 2005. White stated: "Real progress in creating gender equity in the future will require acknowledging the gendered state of our current workplace" (White, 2005, p. 22).

Fowler et al. (2004) conducted research that revealed a tendency for women to stall at the associate professor rank. They discovered that female faculty at the University of Texas at Austin were not represented in the full professor ranks at the same level as male faculty. Fowler et al. proposed several hypotheses to explain this, and showed that a "leaky pipeline" (a term used to indicate that women drop out of the sciences at many stages of their career—during enrollment in high school science, after the bachelor's degree, when they go from assistant to associate professor) was not the reason for the difference over the years.

Geisler et al. (2007) wrote of a process to document the patterns of women's "nonpromotion to full professor" (p. 145). Their study provided evidence at Rensselaer Polytechnic Institute and other universities, that women were not being promoted to the rank of professor as often as were men. Looking at salary data, time in position, and rank, Geisler et al. were able to track "nonpromotion" rates.

Stout et al. (2007) listened to the stories of female faculty to discover why women were not achieving the rank of professor as often as men. Consistent with the earlier work of Fowler et al. (2004), their study showed that it is not necessarily a "leaky pipeline" that is behind this phenomenon, but an "accumulation of disadvantages" (p. 124). According to Stout et al., "Future research should explore the ways in which institutional programs and social networks enable women to gain information and support for advancing to senior faculty ranks in the academy" (p. 140).

To achieve promotion to higher ranks, faculty at most universities and colleges must go through a process typically consisting of work assessment in three areas: teaching, research, and service. Although colleges and universities stress all three areas in faculty evaluation, there appears to be a growing focus on research accomplishments (Whicker et al., 1993). One of the measures of research success often used in the higher education promotion, tenure, and post-tenure review processes is the number of external grants received by a faculty member (Bagilhole, 2002; Bentley & Black, 1992; Crossland, 1995; Gaugler, 2004; Goldsmith et al., 2001; Massey & Wilgern, 1995; Schoenfeld & Magnan, 1994). Schoenfeld and Magnan (1994) stated, “The tender loving care you devote to your students is equaled in importance only by the attention you bring to conceiving and writing research proposals” (p. 299). Similarly, Argon (1995) said, “Individuals will continue to feel pressured to receive funding and publish results as publication records and grantsmanship are used as evaluation criteria in promotion and tenure” (p. 234). Kleinfelder et al., (2003) discovered that writing proposals for external grant funds is a faculty expectation at many, if not most, U.S. universities. In a review of job advertisements for faculty positions, Kleinfelder et al. found that a majority of the ads listed proposal writing as a position requirement. These authors also ascertained that many faculty felt external fund proposal writing was an expectation of their position. Applying for and receiving extramural funds is “fundamental to career development of faculty” (p. 208).

Daniel and Gallaher (1990), Monahan (1993), Dooley (1995), and Boyer and Cockriel (1998, 1999) addressed barriers and supports perceived by faculty as they write proposals for external funds. The results of these studies were used in developing the survey for this study. Several of these studies compared female and male perceptions of those barriers and supports.

Research has shown that female faculty in higher education, in general, do not submit as many proposals for external funds as do male faculty (Boyer & Cockriel, 1999; Waisbren et al., 2008), which may in turn negatively impact their survival and success in academia in terms of tenure and promotion. Mayer et al. (2008), in research examining gender differences in the academic advancement of faculty in medicine, found that female faculty did not publish as many papers or receive as many grants as male faculty. They further noted the “…slow progress of women in medicine in achieving academic rank” (p. 206).

STUDY PURPOSE

The purpose of this study was to explore and understand the barriers and supports perceived by female faculty at the three state universities in Idaho—Boise State University (BSU), ISU, and University of Idaho (UI)—as they write proposals to secure external funds for research, teaching, and service activities. In reviewing the responses of female associate professors, it may be possible to identify issues associated with the impediments and necessary supports likely to increase proposal writing for external funds, and in turn improve faculty chances of achieving promotion to professor.

This study does not include a comparison of the perceptions held by male faculty regarding barriers and supports for proposal writing. The focus of this study was exploratory and descriptive, not comparative. Men may or may not perceive the same issues as barriers and supports; as such, a comparative review of male/female faculty perceptions would be a useful next inquiry.

Research has shown that women have unique faculty perceptions and experiences in academia (Bain & Cummings, 2000; Perna, 2005; Stout et al., 2007). For example, women, traditionally and still today handle the majority of issues related to home and family (Singer et al., 2001;

Young & Wright, 2001). According to Young and Wright (2001), women spend approximately 80 hours/week on home and work responsibilities, while men spend an average of 57 hours on these same activities. Recent research conducted by Mason et al. (2009) showed that many doctoral students (future faculty) feel that academia and the tenure system are not family-friendly institutions. "Less than half of men (46 percent) and a only [sic] third of women imagine jobs in these settings to be somewhat or very family friendly" (p. 3). Given that women typically bear more responsibility for family/life issues, it is logical that when functioning in a setting perceived to be unfriendly toward families, their perceptions would and will differ from those of their male counterparts. This article focuses on this, along with the fact that female faculty face impediments in achieving the rank of professor. This article considers ways to help female faculty secure external funding (because the number of proposals for external funding written is often a criterion for promotion), and suggests that by mitigating barriers and providing supports, research administrators will be better able to help faculty generally, and female faculty in particular, achieve promotion to professor.

METHODOLOGY

After securing human subjects committee approval, 450 female faculty members at BSU, ISU, and UI were sent email messages about the purpose and significance of the study, use of the data, and confidentiality issues, as well as the process for participation in the electronic survey. The email also provided the URL for the survey, inclusive of informed consent information. In an effort to increase the response rate, second and third emails were sent as a follow-up to faculty who did not respond.

This study employed a mixed-methods design. Quantitative data were derived from a self-report survey employing a five-point Likert scale to reflect level of agreement with the survey items (37). The points on the Likert scale ranged from 1—strong barrier/support, 2—moderate barrier/support, 2.5—not applicable to me, but would serve as a barrier/support, 3—marginal barrier/support, and 4—not a barrier/ support to me (Gall et al., 2003). Not a barrier/support was included because the five-point scale may have contained statements that described barriers or supports some of the respondents may not have perceived. Similarly, a sixth response option was added: not applicable to me but would serve as a barrier/support. Qualitative data were derived from two open-ended questions wherein respondents were asked to elaborate on the barriers and supports they perceived in writing proposals for external funds. While qualitative data were collected, these data are not reported in this article since the emergent themes are not relevant to the issue of female associate professors moving to the rank of full professor.

Survey items were initially developed based on (a) information gleaned from the literature review, inclusive of other similarly targeted surveys; and (b) the researchers' expertise in research administration, attained through twelve years of experience in this field at ISU and seven years of previous experience at other universities. From this starting point, the instrument went through expert review and pilot testing. The final survey included 48 items—24 addressed barriers and 24 addressed supports to proposal writing for external funds (Boyer & Cockriel, 1999; Daniel & Galleher, 1990; Mayer et al., 2008; Monahan, 1993). Twenty-seven demographic questions were also asked.

Survey items were analyzed for inter-item reliability, in total, as well as relative to the groupings associated with: all barriers, work barriers, personal barriers; and all supports, work supports, and personal supports. Strong inter-item reliability was demonstrated among all scales (*alpha* > .60 on each total variable scale; see Table 2). Because this study was exploratory and descriptive in nature, the quantitative analysis involved basic descriptive statistics, including response frequencies and corresponding percentages.

Table 2. Scale Titles, Number of Items, and Alpha Reliabilities for Survey

Title of Scale	Number of Items in Scale	Alpha Reliability
Total Barriers	23	.867
Work Barriers	11	.773
Personal Barriers	12	.781
Total Supports	23	.857
Work Supports	11	.850
Personal Supports	12	.721

Note: Survey responses were: 1 = Strong Barrier/Support; 2 = Moderate Barrier/Support; 2.5 = Not Applicable to Me, But Would Serve as a Barrier/Support; 3 = Marginal Barrier/Support; 4 = Not a Barrier/Support for Me

FINDINGS

Demographics

One-hundred and thirty-three surveys were returned for a response rate of 30%. Forty-one respondents (30.8%) were BSU faculty, 68 (51.1%) were ISU faculty, and 24 (18.0%) were UI faculty. The majority were employed full-time (96.2%), and 60.9% were tenured. Associate professors (39.8%) composed the largest faculty response group. Most of the respondents were in the Science, Technology, Engineering, and Mathematics (STEM) disciplines (49.6%), with 13.0% each in the Arts and Humanities, Education, and Social Sciences. As per survey directions, 75.5% of respondents at the associate professor rank indicated they were in a committed partnership, or living with a partner or significant other as of September 1, 2005, and 75.5% did not provide the majority of childcare for dependent children. Of those respondents at the associate professor level living with someone else, 47.2% reported that they did most of the housework. Eighty-six percent of the associate professors reported that they had written proposals for external funds, with 43.4% having written only one proposal. Awards for external funds had been received by 78.4% of the associate professors.

Barrier/Support Perceptions

This study showed that female faculty in higher education faced issues in terms of perceived barriers and supports to the proposal writing process. The presentation of these findings follows, first by work and personal barriers, and then by work and personal supports**,** as reported by respondents who had attained the associate professor rank.

***Barrier perceptions*.** Table 3 provides an overview of female associate professor perceptions of work barriers relative to their efforts to write proposals for external funds. Work barriers were delimited to those focused on specifics in the workplace. Similarly, Table 3 displays personal barrier perception findings—that is, barriers perceived to be individual and/or created by one's choice of lifestyle.

Table 3. Frequencies of Work Barriers Perceived by Female Associate Professors as They Wrote Proposals for External Funds

Barriers—Work	Strong to Moderate Barrier	Not Applicable but Would Serve as a Barrier	Marginal Barrier	Not a Barrier for Me	Not Applicable
Heavy teaching load	45(84.9%)	2(03.8%)	2(03.8%)	4(07.5%)	0(00.0%)
Too many committee assignments	40(75.5%)	2(03.8%)	9(17.0%)	2(03.8%)	0(00.0%)
Lack of knowledge of funding sources	26(49.1%)	2(03.8%)	15(28.3%)	10(18.9%)	0(00.0%)
Inadequate support available at the institutional level to submit a proposal	17(32.0%)	1(01.9%)	18(34.0%)	16(30.2%)	1(01.9%)
Lack collaborators at my university	25(47.2%)	0(00.0%)	14(26.4%)	12(22.6%)	2(03.8%)
Advisor responsibilities for too many students	26(49.0%)	3(05.7%)	16(30.2%)	6(11.3%)	2(03.8%)
Writing grant proposals not required part of my job	10(18.9%)	7(13.2%)	11(20.8%)	10(18.9%)	15(28.3%)
Lack of funds to travel to meet with peers and funding agencies in preparation for writing proposals	29(54.7%)	1(01.9%)	12(22.6%)	11(20.8%)	0(00.0%)
Lack of peer network at my university to offer support in proposal development	30(56.6%)	1(01.9%)	7(13.2%)	14(26.4%)	1(01.9%)
Writing proposals for external funds is not valued at my institution	10(11.3%)	4(07.5%)	5(09.4%)	20(37.7%)	18(34.0%)
Writing proposals for external funds is not necessary in my discipline	7(13.2%)	3(05.7%)	13(24.5%)	18(34.0%)	12(22.6%)

Note: Survey responses were: 1 = Strong Barrier/Support; 2 = Moderate Barrier/Support; 2.5 = Not Applicable to Me, But Would Serve as a Barrier/Support; 3 = Marginal Barrier/Support; 4 = Not a Barrier/Support for Me

As Table 3 reveals, the issues most often reported as barriers to writing proposals for these faculty (i.e., rated as strong to moderate work barriers) were: heavy teaching load (84.9%); too many committee assignments (75.5%); lack of knowledge of funding sources (49.1%); lack of peer network at my university to offer support in proposal development (56.6%); and lack of funds to travel to meet with peers and funding agencies in preparation for writing proposals (54.7%).

Table 4 reveals the following: Lack of a mentor (58.5%) and lack of training in proposal development (47.1%) were the two personal barriers perceived most often as strong barriers. A relatively high percentage of the respondents (approximately 45% to 60%) indicated that several of the barriers were not a barrier for them: discrimination because I am a woman (58.5%); fear of failing to get proposal funded (49.1%); and lack of women with children in my department to serve as a role model (49.1%).

Table 4. Frequencies of Personal Barriers Perceived by Faculty as They Wrote Proposals for External Funds

Barriers —Personal	Strong to Moderate Barrier	Not Applicable but Would Serve as a Barrier	Marginal Barrier	Not a Barrier for Me	Not Applicable
Feel pressure to have children	2(03.8%)	9(17.0%)	6(11.3%)	23(43.4%)	13(24.5%)
Lack of training in proposal development	25(47.1%)	1(01.9%)	12(22.6%)	14(26.4%)	1(01.2%)
Discrimination because I am a woman	6(11.4%)	3(05.7%)	11(20.8%)	31(58.5%)	2(03.8%)
Work not good enough to get funded	17(32.0%)	3(05.7%)	11(20.8%)	19(35.8%)	3(05.7%)
Uncomfortable using “life-friendly” policies such as stop the tenure clock for childbirth	6(11.5%)	15(28.3%)	1(01.9%)	17(32.1%)	14(26.4%)
Major childcare provider in family	5(09.5%)	17(32.1%)	5(09.4%)	10(18.9%)	16(30.2%)
Major care provider for adult family member	4(07.5%)	20(37.7%)	6(11.3%)	11(20.8%)	12(22.6%)
Lack of a mentor	31(58.5%)	0(00.0%)	12(22.6%)	8(15.1%)	2(03.8%)
Lack of publications so would not be competitive	24(45.3%)	4(07.5%)	16(30.2%)	6(11.3%)	3(05.7%)
Lack of other women in my department	9(17.0%)	4(07.5%)	6(11.3%)	23(43.3%)	11(20.8%)
Fear of failing to get proposal funded	9(17.0%)	3(05.7%)	14(26.4%)	26(49.1%)	1(01.9%)
Lack of women with children in my department to serve as a role model	4(07.6%)	4(07.6%)	6(11.3%)	26(49.1%)	13(24.5%)

Note: Survey responses were: 1 = Strong Barrier/Support; 2 = Moderate Barrier/Support; 2.5 = Not Applicable to Me, But Would Serve as a Barrier/Support; 3 = Marginal Barrier/Support; 4 = Not a Barrier/Support for Me

Support perceptions. Supports perceived by faculty when writing proposals for external funding were analyzed next. Table 5 displays faculty perceptions relative to work supports associated with writing proposals for external funds, and reveals that eight of the eleven work-related items were perceived as strong to moderate supports by over 50% of the respondents. These included: writing proposals for external funding is valued at my institution (73.5%); adequate university infrastructure for writing and submitting proposals (71.6%); collaborators at my university (66.1%); and assistance in grant proposal preparation (66.0%). As indicated, institutional support was perceived as a strong support in the proposal writing process.

Table 5. Frequencies of Work Supports Perceived by Female Faculty as They Wrote Proposals for External Funds

Supports—Work	Strong to Moderate Support	Not Applicable but Would Serve as a Support	Marginal Support	Not a Support for Me	Not Applicable
Number of proposals written and submitted is used in tenure or promotion decisions	26(49.0%)	4(07.5%)	11(20.8%)	8(15.1%)	4(07.5%)
Proposal writing workshops are available	29(54.7%)	1(01.9%)	17(32.1%)	6(11.3%)	0(00.0%)
Assistance contacting funding sources	33(62.3%)	0(00.0%)	15(28.3%)	3(05.7%)	2(03.8%)
Assistance in grant proposal preparation	35(66.0%)	1(01.9%)	14(26.4%)	3(05.7%)	0(00.0%)
Writing proposals for external funding is valued at my institution	39(73.5%)	3(05.7%)	9(17.0%)	1(01.9%)	1(01.9%)
Internally funded grants providing release time to write proposals	34(64.2%)	3(05.7%)	11(20.8%)	3(05.7%)	2(03.8%)
A proposal writing support network made up of other faculty and staff at the university to talk with about ideas	25(47.1%)	3(05.7%)	18(34.0%)	5(09.4%)	2(03.8%)
Collaborators at my university	35(66.1%)	5(09.4%)	6(11.3%)	6(11.3%)	1(01.9%)
Adequate university infrastructure for writing and submitting proposals	38(71.6%)	0(00.0%)	11(20.8%)	2(03.8%)	2(03.8%)
Number of proposals awarded is used in tenure or promotion decisions	25(47.2%)	3(05.7%)	15(28.3%)	6(11.3%)	4(07.5%)
Writing proposals for external funds is necessary in my discipline	27(50.9%)	1(01.9%)	10(18.9%)	7(13.2%)	8(15.1%)

Note: Survey responses were: 1 = Strong Barrier/Support; 2 = Moderate Barrier/Support; 2.5 = Not Applicable to Me, But Would Serve as a Barrier/Support; 3 = Marginal Barrier/Support; 4 = Not a Barrier/Support for Me

Personal supports associated with writing proposals for external funds are displayed in Table 6. This table shows that 83.0% of respondents reported that their partner and/or family were supportive of academic work as a strong to moderate support. Other strong to moderate supports perceived when writing proposals for external funds were: confident that ideas are worthy of external funds (77.4%), personal knowledge of proposal development process (69.8%), and a life partner who shares equally home/family duties (69.8%).

Table 6. Frequencies of Personal Supports Perceived by Female Faculty as They Wrote Proposals for External Funds

Supports—Personal	Strong to Moderate Support	Not Applicable but Would Serve as a Support	Marginal Support	Not a Support for Me	Not Applicable
"Life-friendly" policies in place at my university, such as stop the tenure clock or help finding a trailing spouse a job	12(22.6%)	10(18.9%)	10(18.9%)	8(15.1%)	13(24.5%)
Personal knowledge of proposal development process	37(69.8%)	0(00.0%)	11(20.8%)	4(0.5%)	1(01.9%)
Department chair is understanding when I must deal with life issues such as elder or childcare	25(47.2%)	11(20.8%)	8(15.1%)	5(09.4%)	4(07.5%)
A life partner who shares equally with home/family duties	37(69.8%)	8(15.1%)	2(03.8%)	2(03.8%)	4(07.5%)
University calendar is same as local school district	14(26.4%)	16(30.2%)	2(03.8%)	7(13.2%)	14(26.4%)
Partner and/or family is supportive of academic work	34(83.0%)	6(11.3%)	1(01.9%)	1(01.9%)	1(01.9%)
My desire to write proposals for external funds	34(64.2%)	2(03.8%)	14(26.4)	2(03.8%)	1(01.9%)
A mentor	33(62.3%)	4(07.5%)	9(17.0%)	3(05.7%)	4(07.5%)
Childcare provided by university	4(07.6%)	25(47.2%)	2(03.8%)	8(15.1%)	14(26.4%)
Confident that ideas are worthy of external funds	41(77.4%)	5(09.4%)	6(11.3%)	1(01.9%)	0(00.0%)
An adequate number of publications, so as to be able to show my expertise in the field	35(66.0%)	3(05.7%)	11(20.8%)	2(03.8%)	2(03.8%)
My work schedule is such that I have time to write proposals	27(51.0%)	5(09.4%)	7(13.2%)	14(26.4%)	0(00.0%)

Note: Survey responses were: 1 = Strong Barrier/Support; 2 = Moderate Barrier/Support; 2.5 = Not Applicable to Me, But Would Serve as a Barrier/Support; 3 = Marginal Barrier/Support; 4 = Not a Barrier/Support for Me

DISCUSSION

According to Park (1996):

Less external research monies, combined with an increased internal emphasis on the importance of research has made current tenure and promotion criteria increasingly difficult to meet. This has been especially true for women who may have little time (and in some cases, little inclination) for grant-writing and article-publishing given their extensive teaching and service responsibilities and their tendency to take these responsibilities seriously. (p. 82)

Female faculty write fewer grant proposals for external funds than male faculty and, as noted above, proposal writing is often taken into account in tenure and promotion decisions (Boyer & Cockriel, 1998; Vesilind, 2000). This may play a part in the observed reality that women often seem to be "stuck" at the associate professor level (Stout et al., 2007).

Because faculty are increasingly being encouraged and/or even required to bring in external funds, facilitating faculty efforts to write proposals for external funds generally, and female faculty efforts in particular, will require: (a) attending to the barriers and supports that impact those efforts; and (b) changes in university policy, practice, and structure to provide a more facilitative and ultimately level playing field for all faculty. The findings reported in this study revealed that the barriers and supports ranked most often as strong to moderate were those defined as work barriers/supports, a fact that validates using the information gathered from this study to provide foundational support for data-based decision-making regarding needed institutional changes. Based on this, the following recommendations are offered in terms of alleviating barriers and building supports.

Alleviating Barriers

As noted, heavy teaching loads and too many committee assignments were listed as strong to moderate barriers by over 75% of the respondents. Women are often assigned more courses to teach, especially those at the lower level, such as lecture courses, which often have large numbers of students and more grading work (Etzkowitz et al., 2000; Rosser, 2004). Women also tend to take on, through volunteering or assignment, more committee work, often because a lone female department member is needed to provide a female presence. This practice further disadvantages minority women (Toth, 1995). Department chairs need to monitor the course load and committee service of all faculty to ensure that female associate professors are not overloaded in terms of teaching and committee work, to the detriment of proposal writing efforts.

Waisbren et al. (2008) posited that a lack of female faculty at higher ranks who could serve as mentors for junior-level female faculty might add to the differences in the number of grant proposals written by women as compared to men. Thirty-one, or 58.5%, of the respondents in this research rated lack of a mentor as a strong to moderate barrier. Providing a mentoring system at universities could be of assistance as faculty move through the academic ranks. Mentors can provide guidance with the promotion process or specifically with the proposal development process (Gardiner et al., 2007). Gardiner et al. (2007) found "mentees attracting four times the external research income" as compared to faculty who did not have a mentor (p. 440). While not a traditional function of a research administration office, this office could: (a) initiate contact and collaboration with faculty development offices/centers to suggest faculty mentorship program curricula inclusive of information about, and networking opportunities for, external funding proposal writing; and/or (b) lead efforts to develop a proposal writing mentorship program.

Lack of travel funds to meet with peers and funding agencies was indicated as a strong to moderate barrier by 54.6% of the respondents. Lack of a peer network was reported by 56.6% of the respondents as a strong to moderate barrier. These barriers are similar to those noted by female faculty in higher education in general. Cooper and Stevens (2002) and Johnsrud and Atwater (1993) discovered that one of the barriers often cited by female faculty is isolation. Rosser and Lane (2002) conducted a study of women who had received Professional Opportunities for Women in Research and Education (POWRE) awards from NSF in 1997–2000.

In 2000, 30.5% listed “low numbers of women, isolation, and lack of camaraderie/mentoring” as significant career challenges for them as higher education faculty (p. 167). Increasing faculty travel funds would facilitate options and opportunities for faculty to meet with collaborators and/or with funding source representatives. Many research administration offices provide funds for travel, and increased cognizance of funding distribution (based on sex) could be an important foundational step in considering how best to support female faculty. If women are not applying for travel fund support, perhaps more outreach could be engaged to increase funding opportunity awareness. In addition, facilitating internal collaboration opportunities through networking meetings could help counter this barrier and benefit female faculty. Research administration offices can provide services to facilitate such meetings. Informal gatherings, workshops, seminars, and/or brown-bag presentations could be scheduled to increase cross-disciplinary research activity and opportunity awareness.

Building Support

Supports ranked as strong to moderate included adequate university infrastructure for writing (71.6%) and submitting proposals and assistance in grant proposal preparation (66.0%). Lack of knowledge of funding sources was reported as a strong to moderate barrier by 49.1% of the respondents. These items, which reflect services provided by most universities through an Office of Research or Sponsored Programs, and are consistent with this research, should be continued and strengthened. By becoming aware of the services faculty perceive as supports and those that they feel pose barriers, research administrators can provide more meaningful and effective assistance to all faculty.

Perhaps one of the important issues revealed through this research concerns the functioning of the Sponsored Programs/Research Administration office. The three universities represented in this study have traditional research administration/sponsored programs services, but many respondents indicated that they perceived a lack in some of these traditional services, or indicated they were not aware of the availability of such services. This research helps make the case regarding the importance of context-specific knowledge. Knowing the faculty of one’s university is vital to providing them with services. It is important to know if certain segments of the faculty perceive barriers to proposal writing and offer insights into how those barriers might be overcome. Excessive reliance on email communications and “cookie-cutter” services may not be effective or appropriate. University administrators can use this knowledge to ensure that available resources are put to the most efficient use. Research, such as has been described in this article, provides a foundation for awareness.

CONCLUSION

Recent research has shown that women do not progress to the rank of professor as quickly or as often as men do. To achieve higher rank, faculty must be successful in teaching, research, and service. As noted, one of the measures of successful research is the submission and receipt of grant awards from external agencies. In many instances women do not write and submit as many proposals for grant funds as men do. As state support for public institutions declines and more emphasis is put on proposal writing, faculty in general and female faculty in particular will need to become increasingly productive in terms of writing proposals for external funds. Alleviating barriers and strengthening supports has the potential to further, and better, support faculty endeavors to write proposals for external funds

As stated by Waisbren et al. (2008):

> It is critical that we bring more stringent analysis to the question of the gender disparity in grant funding. Otherwise, potentially biased impressions prevail, often preventing the initiation of remedial steps to increase grant success and academic advancement for women. (p. 213)

This study contributes to the empirical body of knowledge regarding the roles and realities of female faculty in higher education as they work to write proposals for external funds. As such, it not only provides support for the initiation of remedial steps to increase grant success, and thereby academic advancement for women, but specifically identifies practice-based options and opportunities to help alleviate barriers and strengthen needed supports. It can also help research administrators further their knowledge of how to help faculty in their pursuit of external grants.

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An Intervention to Increase Publication of Research Results by Faculty and Medical Residents: A Case Study

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ABSTRACT

Writing and publishing articles in peer-reviewed journals is often a challenge for clinical faculty. Yet these scholarly activities are critical to their careers, contributing to achieving promotion and tenure, and establishing a record of scholarly work to form a basis for successfully competing for grant funding. East Tennessee State University's Department of Family Medicine Division of Research, which provides a variety of research support services, developed an intervention to teach clinical faculty to write. A half-day workshop addressed writing skills for development and submission of manuscripts and included how to choose the right journal, managing writing time, and the structure and content of different article types. Faculty-resident pairs, most of whom had never written for publication, worked with experienced faculty writers for several months after the workshop. Peer support was provided throughout the process of manuscript development and submission and, as necessary, revision of manuscripts for resubmission. Publication in peer-reviewed journals was tracked over four years. Publication rates of participants increased in 2006, the year after the workshop was conducted, and remained at a higher level through 2008. A short-term educational intervention with peer-support and mentoring resulted in an increase in publications by clinical faculty.

INTRODUCTION AND PROGRAM GOALS

East Tennessee State University's (ETSU) Department of Family Medicine Division of Research provides support to clinical faculty for all aspects of conducting research. Support includes providing advice on experimental design, data collection and analysis, proposal writing and submission of proposals, and assistance with the administration of funded projects. This support is important to the success of ETSU's clinical faculty, whose patient care and teaching obligations leave little time for the research and scholarly writing necessary for achieving tenure and promotion.

Through grants awarded to ETSU by the Academic Administrative Units in Primary Care Program of the U.S. Department of Health and Human Services, Bureau of Health Professions (2002–2008) to train primary care faculty in research skills, a number of research projects were conducted. Details of this initiative, which included a formal mentoring program and research skills-building seminars, are described in Tudiver et al. (2008). However, program evaluation surveys of the clinical faculty researchers revealed that in spite of the research training and support, nearly all felt ill-equipped to write about their research in a format acceptable to peer-reviewed journals.

Therefore, the Director of the Research Division, a clinical faculty member with research and writing experience, and the division's science writer, developed an intervention with the purpose of teaching clinical faculty members to write for publication in peer-reviewed professional journals.

BACKGROUND AND PLANNING

Many clinical faculty have difficulty publishing articles in peer-reviewed journals. There is evidence from the literature that often clinical research reported at conferences is never subsequently published (Scherer et al., 1994; Weber et al., 1998). This occurs across many diverse disciplines, such as ophthalmology, pediatrics, orthopedics, and veterinary anesthesiology (Dyson & Sparling, 2006; Riordan, 2000; Sprague et al., 2003; Weber et al., 1998). A meta-analysis of 11 studies by Scherer et al. (1994) showed that only about 51% of abstracts were subsequently published as full articles. Von Elm et al. (2003) examined 19,123 abstracts from 234 biomedical meetings; only 21% were published within two years of the meeting, 41% within four years, and 44% within six years of the meeting at which they were presented.

Numerous barriers to publishing have been cited, and commonly include lack of time (Dyson & Sparling, 2006; Oermann, 2003; Sprague et al., 2003), training (Grzybowski et al., 2003), and mentoring/ peer support (Grzybowski et al., 2003; Stepanski, 2002). Sprague et al. (2003) asked 306 authors of conference abstracts that were not subsequently published to identify barriers to publication; 46.5% reported that they lacked time for writing; 31% reported that the research was still in progress; and about 33% described a lack of understanding of individual responsibilities of collaborators as a problem. Historically, medical schools and residencies have provided little training or experience in scholarly writing (Grzybowski et al., 2003). Although in 2007 the Accreditation Council for Graduate Medical Education (ACGME) established a new research requirement for medical residents that includes writing or presenting results (ACGME, 2009), most clinical faculty in academia completed residency training prior to those requirements. Therefore, lack of training is a common impediment.

While many books and journals provide information to help with the writing process (Arceci, 2004; Cetin & Hackam, 2005; Happell, 2005; Iles, 2003), the most successful strategies reported have used writing workshops (Bydder et al., 2006; Hekelman et al., 1995; Sommers et al., 1996) and peer support (Grzybowski et al., 2003). Bydder et al. (2006) conducted a short (3-hour) workshop for eight participants at the Annual Meeting of the North Carolina College of Radiologists, to encourage the radiologists to publish the research presented at the conference. Workshop content included skills for clearer writing, the structure of scientific articles, and choosing topics and journals. Pre- and post-workshop questionnaires showed that participants' perceptions of their own writing skills increased, as did their understanding of article structure and where to go for writing advice. The Case Western Reserve University Department of Family Medicine, in contrast, developed a more extensive program consisting of a seminar on developing an article outline, an outside assignment to write a detailed outline, and a full-day workshop during which a journal editor discussed review of submissions and other related topics (Hekelman et al., 1995). A senior-level faculty advisor was assigned to each participant, and publications were tracked over three years. A significant increase in participants' publication rates was observed. A different approach to increasing publication at the University of British Columbia used collaborative peer writing groups that met regularly to provide writing support; publication productivity increased for participants (Grzybowski et al., 2003).

Unlike other writing interventions reported in the literature, we developed a short-term intervention with longer term follow-up to track the publication productivity of participants over several years. In this way it was possible to observe 1) whether this intervention increased productivity and 2) if increased productivity would continue over time. The ETSU intervention was based in part on workshop formats previously described. Workshop content was taken from the Research Director's and science writer's experiences and the *Guidebook to Better Medical Writing* by Robert Iles (2003), which was used for reference. A short-term half-day workshop format was used, with follow-up by the Research Director, science writer, and other experienced faculty writers until a manuscript was accepted for publication.

Because of the demonstrated value of peer support (Grzybowski et al., 2003; Tudiver et al., 2008), a mentoring relationship was also established. Tenure-track faculty members with a publication requirement for promotion and tenure were invited to attend a planning meeting where each identified a medical resident with an interest in either writing, research, or a career in academia. Twenty faculty members and residents attended the workshop.

WORKSHOP FORMAT

Each workshop participant pair (N = 20) brought data, an abstract, or slides if research had been presented at a conference. The first half of the workshop focused on general skills and considerations related to the manuscript development and submission process (Figure 1). Participants were asked what they thought the barriers were to their own writing; their answers paralleled those described in the literature. The Research Director discussed motivations for academic writing. He then described his experiences as a journal editor, with an emphasis on the peer review process. He highlighted what he looked for in an article and the logistics of how a manuscript is handled by a journal after submission. The science writer addressed how to find time for writing. Participants completed an exercise (Iles, 2003) in which they selected a topic with which they were familiar and wrote for three minutes on that topic. The number of words produced in that time was then extrapolated to estimate how long it might take to write an article, and what other activities, such as reviewing the literature, must be factored in. Handouts were distributed with tips for better and more appropriate writing. The presenter stressed not only the importance of knowing the subject matter well, but also understanding the interests and level of expertise of the readership of the target journal. A review of common rules of grammar, punctuation, and spelling was presented with entertaining examples from the best-selling grammar book, *Eats, Shoots, and Leaves* (Truss, 2003). A checklist for choosing the right journal was provided. The list included such considerations as whether the manuscript matched the journal's scope, the journal's inclusion in PUBMED or other citation indices, the average time from submission to publication, and the acceptance rate (Iles, 2003).

1. Group Discussion: Barriers to Writing and Publishing
2. Motivations to Write
3. The Peer Review Process
4. Writing Time Exercise
5. Grammar, Punctuation, and Spelling
6. Choosing the Right Journal

Break

7. Format and Content of Different Article Types:
    a. Qualitative and Quantitative Research
    b. Educational Program
    c. Clinical Practice Model
    d. Clinical Case Report.
8. Software to Facilitate Writing
9. Breakout: Manuscript Outline Development

Figure 1. Writing Workshop Agenda

The second half of the workshop focused on the structure and content of different types of manuscripts. The presenters used published articles written by more experienced faculty members in the department as examples of article types including qualitative and quantitative research, an educational program description and evaluation, a clinical practice model, and a clinical case report. Because the majority of participants planned to write a research article, most time was spent on that structure. Using the example article, participants identified the content included in the Introduction, Materials and Methods, Results, and Discussion sections. Developing other components (title, authors) and sections (abstract and conclusion) was discussed. Participants were asked which section they would write first, and the group arrived at a consensus that one does not necessarily write the manuscript in the order in which it will finally appear. The structures of other article types were compared with the research article to demonstrate similarities and differences. A medical librarian demonstrated use of software to facilitate manuscript submission, including the edit/track changes function in Microsoft Word and the Endnote reference management system. A small-group breakout session allowed participants to develop outlines for their articles.

For several months, faculty-resident teams drafted and revised manuscripts, with mentoring provided by the Research Director, science writer, and several senior-level faculty members in family medicine and other primary care departments, including nursing. Workshop follow-up also consisted of individual assistance with journal selection. Division of Research support faculty and staff also helped with post-review revision of manuscripts for resubmission.

RESULTS AND DISCUSSION

Table 1 shows the number of articles published by workshop participants during the year in which the workshop was conducted (2005) and three years thereafter. Only two articles were published by the participants in 2005. This is not surprising as the manuscript development, submission, resubmission and publication process for most biomedical journals usually takes at least a year. Workshop participants published nine articles in 2006 and 7 articles in 2007 and 2008.

Table 1. Number of Peer-Reviewed Publications of Workshop Participants, 2005–2008[A]

Year	# of Publications
2005	2
2006	9
2007	7
2008	7

[A] Workshop was conducted in 2005.

The workshop provided considerable practical information needed by the beginning writer. However, the mentoring on two levels—less experienced faculty writers mentoring medical residents, and more experienced faculty or research administrators mentoring faculty-resident pairs—was important for the successful completion of the articles. Peer support through the journal selection and review process was very important, particularly at the resubmission stage. Rejection of a manuscript was discouraging to the individual faculty members and residents, especially those new to the writing process. Most of the workshop participants had never published a manuscript, or had not done so for many years. Meeting with a more experienced colleague who could highlight the positive reviewers' comments and show how the critique could be used to guide the revision was an important step to assure that the first rejection did not end the submission process. The fact that the group's publication rate not only increased for 2006, the year following the workshop, but remained at a higher level in 2007 and 2008 compared with 2005, is indicative that this intervention may have fostered longer-term productivity. Most of the residents and some of the faculty have since left ETSU. However, those who have moved to other academic settings have continued to write and publish.

What implications does this study have for research administrators? As the discipline grows and matures, and publication of research becomes more important to faculty who want to achieve tenure and successfully apply for grant funding, the scope of the research administrator's duties and responsibilities likewise is expanding. Individuals with backgrounds in English, journalism, and technical writing are among the research administration ranks, assisting faculty with writing proposals and manuscripts. Often these research administrators do not have a background in medicine or other disciplines of the faculty to whom they provide assistance. The ETSU writing workshop and the peer-support strategy can be adapted for different disciplines and conducted with a minimal of resources. The follow-up guidance can be provided by the research administrator calling upon senior-level faculty members across many departments. This provides a new, but certainly appropriate, role for the research administrator in fostering scholarly productivity that is a precursor to acquiring the grant support that is more traditionally in the scope of research administration.

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Assessing Technology Transfer Performance

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ABSTRACT

This paper presents an analysis of the Association of University Technology Managers (AUTM) annual U.S. Licensing Activity Survey data for 2007. Before performing the analysis, the institutions were first categorized into three "peer" groups (large, medium, or small) based on size of research expenditures so that more appropriate comparisons could be made. To assist in the interpretation of the results, we suggest some factors that may affect institutional performance in certain areas.

INTRODUCTION

Each year when the Association of University Technology Managers (AUTM) annual survey results are published, invariably the statistic that generates the most interest is the level of royalty income generated by universities. Despite mission statements that may not place royalty income at the top of the list (e.g., instead, open innovation may be a primary goal) many university administrators, state officials, and policy makers nonetheless often use that statistic as the key measure of an institution's technology transfer performance. For the reasons elaborated below we (as do many practitioners) believe it is difficult to use royalty income alone as the sole measure of technology transfer performance.

Nearly two decades of AUTM survey data have shown that a large money-making license is a relatively rare event: only about 0.5% of active license agreements generate over $1 million in royalty income[1], and most generate much less. Income is more a function of "hitting the grand slam," i.e., being in the fortunate position of having licensed a technology that is a huge commercial success or negotiating an equity deal to a company whose stock greatly appreciates. Although skill in negotiating the deal is critically important (to be in a position to capture the value from the intellectual property [IP]), what is also important is having as many high-quality "technologies" as possible in play. This "portfolio approach" helps to increase the odds of "winning the lottery." For example, the average ratio of license + option agreements executed in a given year to invention disclosures is about 1:5 (actual median percentage was 18.9% for all U.S. academic institutions responding to the 2007 AUTM survey). This implies that an institution receiving 100 disclosures per year should expect on average to negotiate about 20 licenses and option agreements per year. (This does not necessarily mean that 20% of all disclosures received will eventually get licensed because some, perhaps many, of the licenses executed in a given year may be based on technologies disclosed in previous years.) As mentioned above, only about 0.5% of all license agreements are "home runs" (million dollar royalty generators), and fewer still are "grand slams." Therefore, for every 200 active license agreements the expectation is that one will be a "home run." Assuming half of the 20 agreements executed above were license agreements and the volume of disclosures (100/year) and deal flow remain constant (10 licenses/year), the expectation is that this hypothetical institution will have a "grand slam" roughly once every 10–20 years (1 home run = 0.005 x 10 license/yr. x 20 yrs.).

Based on the above analysis of the infrequent nature of "grand slam" licenses, it stands to reason that there should be a correlation between total number of active royalty-yielding licenses and options that an institution holds and royalty income. One would expect that the higher the number of active options and licenses, the greater the royalty income because the more active agreements in play, the greater the odds that one will be a home run. Indeed, there is a correlation, albeit not a very strong one (see Figures 1 and 2). Figures 1 and 2 are identical except that Figure 1 includes New York University's exceptional income of $791,210,587 for 2007 and Figure 2 does not.

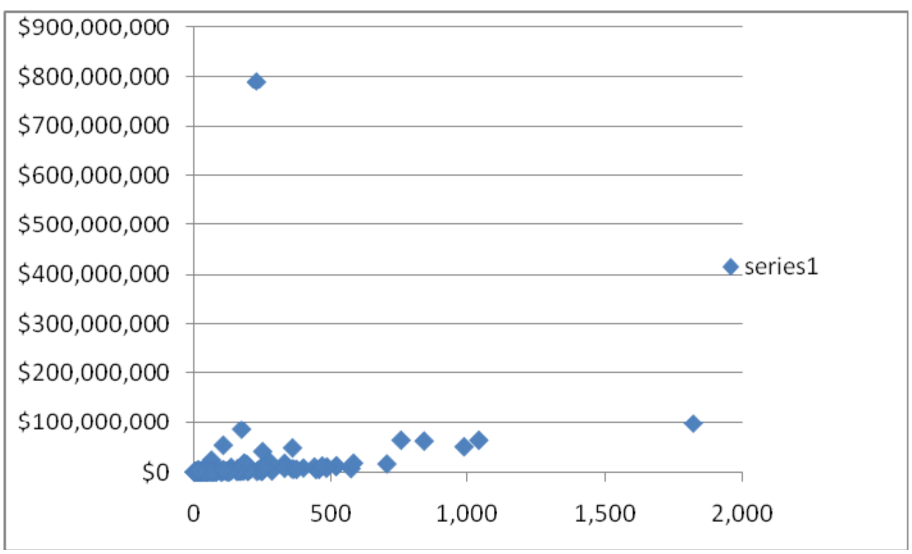

Figure 1. Income vs. Number Active Licenses/Options (with outlier)

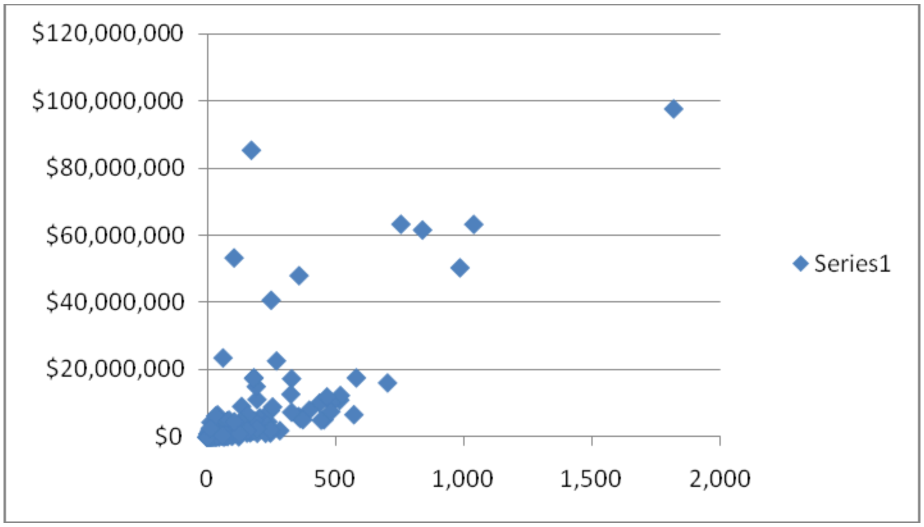

Figure 2. Income vs. Number Active Licenses/Options (without outlier)

A similar correlation is seen if one compares aggregate income over the previous five years versus the number of active licenses/options. See Figures 3 and 4, which are identical except that Figure 3 includes two outliers and Figure 4 does not.

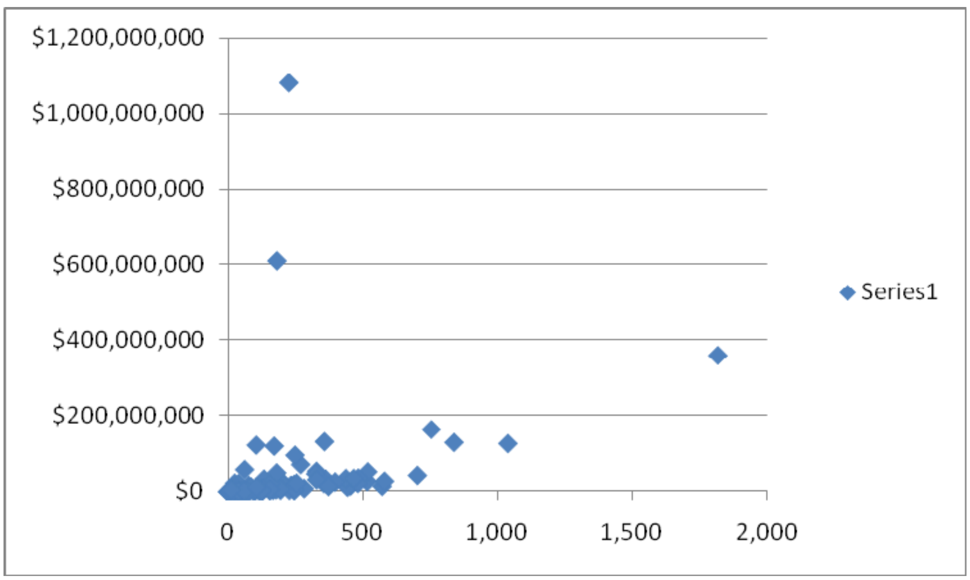

Figure 3. Aggregate Income vs. Active Licenses/Options (with outliers)

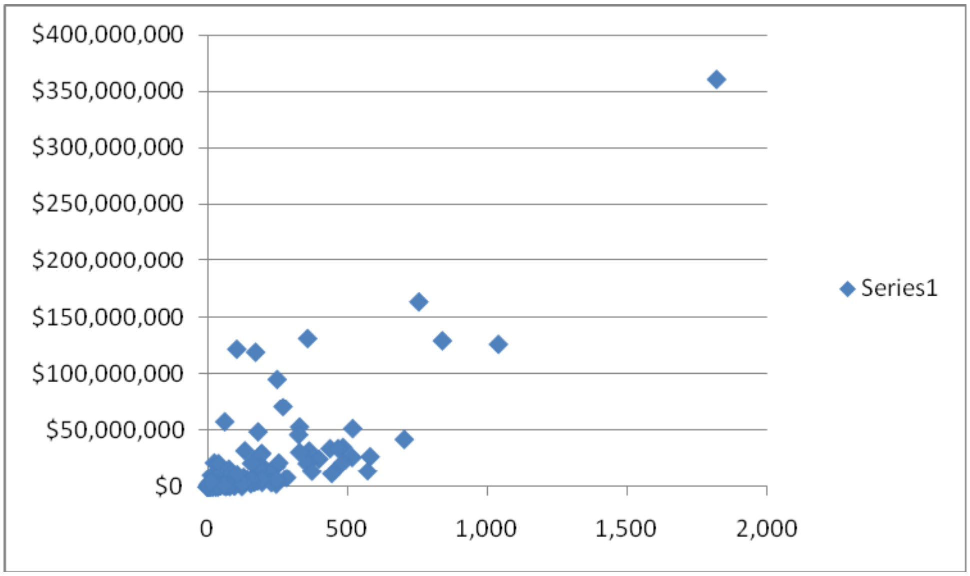

Figure 4. Aggregate Income vs. Active Licenses/Options (without outliers)

This rough correlation may just be reflective of the unpredictable nature of the marketplace and stock market, which is beyond the control of the technology transfer office. To some extent, due to external factors (e.g., advent of a disruptive technology, shift in trade policy, availability of risk capital), marketplace success is even beyond the control of company managers (no one can guarantee success—at best, all one can do is estimate the probability for R&D, regulatory, and commercial success).

If royalty income or ROI alone is not a good measure of assessing technology transfer performance, what is? We do not believe any one measure is sufficient; rather, it is our opinion that a number of metrics need to be assessed, such as volume of disclosures (cultural measure), evaluation of commercial potential, patent/legal expense management, marketing effectiveness, number of industry partners/contracts, etc., in order to develop a more complete picture of performance. Only by looking at all the aspects of technology transfer can one draw any meaningful conclusions. (Most important is how well the public is benefiting from the new innovations being developed at the country's academic and non-profit institutions. This is not something that can be easily quantified, although AUTM is attempting to do so in a qualitative manner through their excellent series of Better World Reports.)

Using the most recent 2007 AUTM survey data (AUTM, 2007) (for the purpose of this analysis it was not important which survey year's data were used), we dug a little deeper. At the risk of being compared to a paleontologist who, using just fragmentary fossil remains, makes big leaps or deductions about the lives and habits of dinosaurs, we attempted to see what conclusions we could tease out of the data. Before conducting the analysis, the academic institutions being surveyed were first grouped into three categories (large >$250 million R&D expenditures, medium >$75 million <$250 million, or small >$10 million <$75 million) based on size of research enterprise. It may be inappropriate to compare institutions with widely varying sizes of their research enterprise (e.g., Johns Hopkins University, which had $1.1 billion in R&D expenditures in 2007, to Duquesne University, which had $11 million in R&D expenditures). In our opinion it is more appropriate to compare institutions among their peers.

While it is difficult to make firm conclusions based on the analysis of just one year's compilation of technology transfer performance statistics (arguably 5 year cumulative data might be more instructive), some interesting observations were made. Some of the observations raise additional questions that may require collecting additional information not found in the current survey. Getting answers to these questions will also require an honest appraisal of the technology transfer offices themselves as well as external factors affecting the offices' performance.

It is hoped that this analysis will aid others (in particular VP Research, policy makers, etc.) in assessing their institution's technology transfer operations and prompt them to delve deeper into what might be the cause of any major deviations from the norm. For example, an institution may have a high reimbursement rate for patent/legal expenses that ordinarily would be viewed as a positive. However, it could also mean that the institution has an aversion to risking its own money on patent applications and may only file if they have a licensee or optionee willing to foot the bill. While this cautious approach may make sense for some institutions and appear on the surface that the office is managing their patent/legal budget wisely, it will undoubtedly limit the portfolio of patent protected technologies available for licensing, and hence the opportunity for future royalty income.

Analysis of 2007 AUTM Data by Institution Size

Table 1 shows the median, maximum, and minimum values calculated for a variety of technology transfer metrics. Median rather than average values were determined because we did not want any outliers to skew the results and give a false picture of typical performance. According to the table, most institutions average approximately four new invention disclosures per $10 million in R&D expenditures. The rate is slightly greater for the smaller institutions. Disclosure rate is indicative of an institution's innovation productivity or culture. A low disclosure rate may mean that more educational and outreach activity is needed to encourage researchers to seek opportunities for patentable innovations in their research. Or it may simply mean that the type of research being conducted is not conducive to inventions—e.g., more behavioral or clinical research rather than scientific or engineering research. It may also mean that the faculty do not hold the view that participation in technology transfer helps advance their careers (reappointment, tenure, and promotion). To get a better understanding of the reason for "atypical" results, either positive or negative, one would have to investigate the cause of either the lower or higher than norm productivity. Top performers in FY2007 are shown in Table 2.

Table 1. Technology Transfer Metrics[1]

Size Inst[2]	Statistic	Disclosures/ $10 MM R&D	Start-ups/ $100 MM R&D	ROI[3]	%Patents filed/ disclosure	%Issued patents/ disclosure	%Lic&Opt/ Disclosure
	Median	3.6	0.9	1.5%	49.7%	18.8%	23.6%
Large	Max	14.4	6.6	265.6%[4]	131.8%	46.8%	111.6%
	Min	1.6	0	0.1%	22.0%	5.0%	8.1%
	Median	4.0	1.3	0.6%	59.6%	16.9%	17.8%
Medium	Max	10.0	5.2	38.4%	267.6%	85.0%	172.9%
	Min	0.9	0	0%	0%	0%	0%
	Median	5.1	1.9	0.6%	62.5%	13.3%	13.7%
Small	Max	38.6	22.9	15.4%	383.3%	50.0%	100.0%
	Min	0.6	0	0%	0%	0%	0%

[1]Calculated from AUTM 2007 Annual Survey data
[2]Size Inst: Large >$250 MM R&D; Medium >$75 MM <$250 MM; Small <$75 MM
[3]ROI – Return on Investment ((license income/R&D expend)*100)
[4]large ROI due in part to one time event, i.e., NYU partial royalty cash out

Table 2. Ranking Disclosure/$10 Million R&D Expenditures

Category	Rank	Institution	Statistic
	1	Calif. Inst. Tech	14.4
	2	U. Florida	6.9
Large	2	U. Utah	6.9
	4	Georgia Inst. Tech	6.6
	5	Stanford U.	5.7
	1	Drexel U.	10.0
	2	Rice U.	9.7
Medium	3	U. Central Florida	9.5
	4	NJ Inst. Tech.	8.2
	5	U. Virginia	8.0
	1	Brigham Young U.	38.6
	2	Louisiana Tech U.	22.6
Small	3	UNC Charlotte	16.8
	4	Ohio U.	15.0
	4	Rensselaer U.	15.0

One area in which the larger, more prestigious universities seem to out-perform the medium and smaller universities is in Return on Investment (ROI) or royalty income as a percentage of R&D expenditures. There could be a number of explanations for this. First, larger institutions have typically put more technologies "in play" over the years and are now reaping the benefits of this increased activity. They were the first to get heavily involved in technology transfer after the passage of the Bayh-Dole legislation and due to their large R&D expenditures have received more disclosures and executed a greater number of license agreements.

Alternatively, larger institutions may have more entrepreneurial-minded and/or inventive faculty who disclose higher-quality or more valuable inventions (e.g., Eminent Scholars, Nobel Laureates, National Academy of Science members, large grant recipients, etc.) than the smaller and medium institutions. These faculty members are sometimes referred to as "star" faculty and are in high demand and heavily recruited. It would be interesting to see if there is a correlation between the number of star faculty at an institution and the royalty income or scientific impact (citation rate) of an institution's inventor's publications (patents and related journal articles) and royalty income.

The performance of more prestigious universities could be due to the "halo" effect of the institution. Sine et al. (2003) have found that after controlling for other factors, a one-unit increase in an institution's *U.S. News and World Report* ranking increased the rate of licensing by 1.5%. (This is not to imply that the less well-known universities cannot be successful at technology transfer. To the contrary, a recent report funded by the National Science Foundation showed that some small and medium-sized institutions can excel at technology transfer [Palmintera et al., 2007].)

The success of larger institutions could also be attributed to having received more technologies that could be the basis of a start-up company. If they take equity in these start-up companies, then they may be benefiting from these equity positions disproportionately (Bray & Lee, 1988). It is well known that only a small percentage (on the order of 2–3%) of disclosures are broad, wide, and deep enough to be the basis of a venture-backed start-up company. An institution receiving 20–30 disclosures each year may only see one platform technology occasionally, whereas an institution that receives hundreds per year may see several suitable candidates each year.

But most probably there is no one single reason for their high performance; rather, it is probably due to a variety of factors. Differences in university technology transfer performance have been the subject of several scholarly articles (Siegel et al., 2007; Thursby & Kemp, 2002). Among others, some of the top contributing factors include: presence or absence of a medical school, private or public institution, and cultural and faculty incentive structure. Top performers in this category are shown in Table 3.

External factors that could affect the ROI metric is the university's position or philosophy in terms of IP rights in research grants and contracts and/or material transfer agreements (MTAs). If an institution has a high number of active license and option agreements in place (in particular, industry agreements) but is yielding low royalty income from them, one might want to check the IP provisions in the underlying research agreements and MTAs (if there are many) to see how much opportunity is available to benefit from the university's inventions. For example, there has been a recent trend among charitable foundations to require that a royalty-sharing provision be included in their contracts as a condition of receiving their grant. While this may be understandable from the standpoint of the foundation, the net effect is to reduce the amount of income that would otherwise come to the university. Some institutions have made the value judgment that research dollars today are more important than royalty income they might receive from hypothetical IP tomorrow. High royalty income and generous IP rights to sponsors usually do not go hand in hand.

The important role played by universities in economic development is well recognized by most state government leaders, policy makers and the general public. One easily quantifiable measure is the number of new start-up companies spun out of the universities annually. Table 4 shows some of the top performers in this category in 2007, normalized for R&D expenditures. Start-up activity is not only a measure of an institution's innovation productivity but also the whole entrepreneurial ecosystem that has been developed in the area in which it is located. This ecosystem makes it possible for the innovations to be translated into new business and the nascent companies to be nurtured until they can stand on their own. In addition to new technology, start-ups require capital, experienced business professionals, skilled workers, and other resources often in short supply. The technology is only one component in the chain.

Table 3. Ranking Return on Investment (ROI)

Category	Rank	Institution	Statistic
Large	1	NYU	265.6%
	2	Northwestern U.	23.6%
	3	Columbia U.	21.9%
	4	U. Rochester	14.9%
	5	U. Minnesota	11.6%
Medium	1	Wake Forest U.	38.4%
	2	Iowa State U.	7.3%
	3	U. Oregon	5.2%
	4	Tulane U.	4.1%
	5	Carnegie-Mellon U.	2.5%
	5	Tufts U.	2.5%
Small	1	Ohio U.	15.4%
	2	U. Akron	12.5%
	3	Brigham Young U.	9.2%
	4	U. South Alabama	9.0%
	5	Eastern Virginia Med.	3.2%

Table 4. Ranking Start-ups/$100 MM R&D Expenditures

Category	Rank	Institution	Statistic
Large	1	U. Utah	6.6
	2	Northwestern U.	2.8
	3	Calif. Inst. Tech.	2.4
	4	U. Maryland, College	2.2
	5	Park	2.0
	5	Colorado State U.	2.0
	5	NYU	2.0
		MIT	
Medium	1	U. Kentucky	5.2
	2	U. Alabama	5.0
	3	Rice U.	4.9
	4	U. New Mexico	4.5
	5	Drexel U.	4.0
Small	1	Brigham Young U.	22.9
	2	Louisiana Tech. U.	14.1
	3	Stevens Inst. Tech.	10.2
	4	U. Texas Arlington	7.6
	5	Mich. Tech. Inst.	5.3

Over the years we have seen a steady increase in the percentage of disclosures that are drafted into patent applications. Today, it appears that most universities (large, medium and small) are filing patent applications on roughly half of their incoming disclosures. Interestingly, the small and medium institutions are filing a slightly larger percentage of patents than the larger universities (~60% for small and medium vs. 50% for large institutions)—see Table 1. This increase may be due to in part to the ability to file inexpensive provisional applications. There seems to be a growing tendency to file first and then see what interest the technology generates from the market and/or assess it for patentability and commercial potential. At one extreme, Cal Tech files a provisional application on virtually every new disclosure[2]. While there may be merits to this approach it still requires the expenditure of some funds for legal services and it may delay the often difficult regular patent filing decision. Sometimes it can be more difficult to abandon a pending patent than not to file one in the first place. On the other hand, this strategy can pay off if a licensee is found that is willing to pay for the conversion.

As Table 1 indicated, the large and medium institutions have better success at getting their inventions licensed or optioned (23.6% and 17.8%, respectively) than the smaller universities (13.7%). This trend is consistent with the %issued patents/disclosure ratio—18.8%, 16.9%, and 13.3%, respectively. It may reflect the fact that companies prefer to license patented technologies rather than unpatented or patent pending technologies.

Interestingly the larger institutions have a greater percentage of their patent/legal expenses reimbursed by their licensees (46.6%) than the medium and smaller institutions (27.9% and 10.6%, respectively)—see Table 5. One explanation might be that the larger institutions license a relatively greater percentage of their technologies (see above). This is not too surprising since it is very common for the licensor to ask an exclusive licensee to reimburse them for their patent expenses. Alternatively, smaller institutions may be doing more non-exclusive licenses which generally do not bring full reimbursements.

Table 5. Legal Expenses

Size Institution	Statistic	% Reimbursed	Legal Expend./ Patent Filed	Net Legal Expend./ Patent Filed
Large	Median	46.6%	$25,848	$13,394
	Max	136.0%	118,486	73,271
	Min	12.5%	1,718	(2,518)
Medium	Median	27.9%	$18,477	$12,067
	Max	89.4%	141,921	127,067
	Min	0.0%	2,337	1,786
Small	Median	10.6%	$12,070	$8,731
	Max	90.1%	134,546	88,822
	Min	0.0%	2,052	1,228

To get a rough estimate of how much institutions are paying for patent filings, we divided the total amount of money the institution spent on patent/legal expenses by the number of new U.S. patents filed. Granted, not all the money is spent only on the preparation and prosecution of a new patent. Some is spent on maintenances fees for issued patents, foreign filings, continued prosecution of previously filed patents, etc. Nevertheless, it does provide a first approximation of what institutions are paying for a patent application. Worthy of note is that the larger institutions are paying more than the smaller institutions. This is true even if one subtracts for reimbursements. The amount spent per new application is still higher for the large institutions compared to the smaller institutions. While a high number may signal that an institution is paying top dollar for patent/legal services in an effort to get high-quality IP protection, it could also just mean that they incurred some extraordinary expenses that year—e.g., expenses related to a patent infringement lawsuit. Ordinarily, one would think that a low number is better. If it is too low, however, it may be a sign that the institution is filing a high percentage of inexpensive provisional patents. It could also mean that they have hired in-house counsel and are having their staff attorneys write and prosecute the applications.

Two additional metrics not tracked by the AUTM survey but nonetheless useful in our estimation in assessing technology transfer performance are: 1) percentage of patented or patent pending technologies licensed, and 2) degree to which marketing solicitations generate follow-up requests for more information under a non-disclosure agreement (NDA). A high percentage for the first metric tells you whether you are placing your bets on the right technologies (risking your money on the most commercializable technologies). The second metric tells you whether you are marketing your technologies to the right targets. For example, a high response would indicate that you are hitting the mark and doing a good job at market research. (One caveat, however, is that in general it is less difficult to market and license major discoveries made by pre-eminent scientists. Often industry technology scouts come looking for these types of discoveries and little marketing effort is needed. But if conducted, the marketing of these high profile cases will generally result in a high response rate. In some respects, then, it is more impressive to see an office that is successful in marketing and out-licensing a significant but yet non-revolutionary innovation, by a novice researcher without a strong track record. Finding a home for these types of technologies can often be more challenging.)

As the author Fletcher Knebel once said, “smoking is one of the leading causes of statistics.” A corollary might be “technology transfer is one of the leading causes of statistics.” To draw any meaningful conclusions about technology transfer performance, one must take care in interpreting the data. Many parameters can be used to assess the performance of a technology transfer operation. Each parameter provides a measure of a different facet of the office and institution. However, unless one delves beneath the surface to understand the factors that may be affecting these parameters, they will be left with a superficial understanding of the office’s operation. Obviously, it takes more than one year’s worth of data to make a fair assessment of an office, particularly for new offices just getting started in technology transfer.[3] In performing this analysis we did not attempt to account for differences in staffing (level or experience) or budget (e.g., patent/legal budget) which naturally will affect overall performance.

In conclusion, it is our opinion that comparisons between institutions should be done in relation to their peer groups (as Frederick Douglas once said, “You are not judged on the height you have risen but from the depth which you have climbed”). Furthermore, top-line statistical data can sometimes be misleading and lead to erroneous conclusions unless analyses are conducted in view of performance factors. Ultimately, technology transfer offices should be evaluated in terms of the over-riding mission of the university and the primary goal that it is trying to achieve through technology transfer, which can differ from institution to institution (e.g., attract corporate research dollars, generate discretionary income, promote regional economic development, benefit the public, etc.). So while comparisons can be made, each office inevitably must function as best suits the institution in which it is housed.

ENDNOTES

1. Association of University Technology Managers. (2003). AUTM Licensing Survey. Figure US-28 (151/25,979 = 0.6%)

2. Statement by Lawrence Gilbert, J.D., M.B.A., Senior Director, California Institute of Technology, Office of Technology Transfer, during a presentation at AUTM Advanced Topics Course, December 6, 2008, New Orleans, LA.

3. Generally speaking, significant royalty income only comes after the licensed product has reached the market and grabbed market share. It may take offices new to the game 5–10 years

before their licensed technology gets to this point. So it is expected that they will lag in royalty income for awhile.

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Assessment of Benefits from Sponsored Research in Publicly Funded Organizations: A Semi-Empirical Model

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ABSTRACT

Sponsored research undertaken by publicly funded research and development organizations is on the rise across the world and is one of the several means of translating innovative ideas from a research laboratory to the market. Companies forge alliances with publicly funded research institutions by funding research to further develop innovative ideas. In doing so, it is important for such publicly funded organizations to internally assess the potential long-term value created by such projects before undertaking them. Here, we attempt to develop a framework for computing the potential value accruing to a publicly funded research and development organization through such sponsored research projects. Further, we propose a semi-empirical model to evaluate this potential value vis-à-vis the sponsored project fee. Such an assessment helps to define an approach to the choice of projects when confronted with several such opportunities. Data from 40 projects undertaken at the National Chemical Laboratory, Pune, a constituent laboratory of the Council of Scientific and Industrial Research, India, between 2003 and 2007 are used to validate the model.

INTRODUCTION

One of the major objectives of Public R&D Organizations (PRO) is not only to create and generate basic scientific and technical knowledge, but also to translate some of this knowledge from the laboratory to commercially viable solutions in the market place. The Council of Scientific and Industrial Research (CSIR) is one such well-established PRO, which is comprised of a chain of 37 laboratories in India. One of the core values of CSIR (India), enshrined in its charter, is to create value for the industry through use of its research infrastructure, scientific knowledge, and intellectual inputs. CSIR is thus entrusted with a unique purpose—namely, to generate knowledge and knowhow through largely public funding (public goods) and eventually translate this into private goods by transferring the knowledge to industry. In return, the PRO earns monetary income accruing through technology transfer fees, IP licensing fees, and royalty on product sales.[1]

It is essential for a PRO not to be isolated from the realities of the actual marketplace because value creation for society is intimately linked to the business needs of industry in a growing economy. PROs are becoming increasingly aware that it is the industrial customer that keeps research relevant to and focused on real-world problems and opportunities. Accordingly, PROs are experimenting with several business models to commercialize their research and development (R&D) efforts (Kumar & Jain, 2002), and make its research more market-driven without losing its focus on high-quality basic scientific research in frontier areas.[2] Some of the business models that are currently in operation at the National Chemical Laboratory (NCL) include the following:

- Transfer of technology of in-house developed projects
- Licensing of un-encumbered IP
- Sponsored research projects fully or partly funded by industry
- Consultancy and technical services assistance rendered to industry
- Setting up of knowledge alliances with a consortium of industries
- Incubating early stage innovations in the form of entrepreneurial ventures
- Public-private partnerships involving networking of several PROs, academic institutions and industrial partners
- Academic research partnerships sponsored by industry
- Setting up of industry-laboratory joint ventures focused on specific R&D themes

Here, we mainly focus on the business model of sponsored research projects (SRP), wherein the project is business-driven with clearly defined outputs. An SRP results in a product, process, tacit knowledge or intellectual property (Haour, 1992). However, not all SRPs necessarily translate into successful commercializable ventures.

What then are the options available to a PRO to choose projects when confronted with a large number of opportunities beckoned by market pull forces? How does the PRO choose projects with varying contract fees to optimize its internal resources, such as manpower, equipment and other infrastructure facilities, and maximize the long-term value to the organization? How does the PRO ensure that the portfolio of SRPs handled by it at any point meets overall organizational interests?

We analyze various parameters for determining the potential value from a SRP to a PRO and introduce the concept of an index for assessing the value of SRP to PRO. This index is then weighed against the contract value to segregate the projects and determine where an SRP fits into the overall organizational strategy. The proposed model is then validated using projects undertaken between 2003 and 2007 at the National Chemical Laboratory, Pune—a constituent laboratory of CSIR.

An Introduction to the National Chemical Laboratory

National Chemical Laboratory (NCL), Pune, was established in 1950 and is one of the constituent laboratories of the Council of Scientific & Industrial Research (CSIR), India. The NCL is a research and development and knowledge-intensive consulting organization and works primarily in the areas of catalysis, organic chemicals, polymer science & engineering, material sciences, chemical engineering and biochemical sciences.[3] In addition, it has excellent resources, such as combinatorial chemistry, materials characterization, a repository of industrial microorganisms and other analytical support facilities required for research. The NCL has a total staff of about 1,600, of which 860 are permanent staff. Currently, about 420 are students pursuing their Ph.D. degree at the NCL; the rest are research associates and project staff. Approximately 60–70 students earn their Ph.D. degree every year for research conducted at the NCL.

On an average, the NCL is granted about 25 foreign patents and 50 Indian patents each year. In addition, the institution's staff members publish about 400 research papers every year in international journals of repute. The NCL's average revenue earnings from industry, both Indian and global sources, are about US$ 3.0 million per annum, which constitutes 40% of its operating revenue budget.

Potential Benefits Index

In order to quantify the potential value that might accrue to a PRO from an SRP, we created a Potential Benefits Index (PBI). To compute PBI, ten factors broadly pertaining to the client, market, intellectual property, royalties and other intangible outcomes were identified. We felt that these ten factors were generally the most critical factors for determining the long-term benefits shared between an SRP and a PRO. However, depending on the nature of the PRO and the character of research and development activities carried out there, these factors could vary or other factors could be introduced. However, in an overall context, the factors considered were a fair representation of the scenario generally applicable to most of the PROs. The ten factors taken into account under the three broad classifications included the following (see Venugopal et al., n.d.):

(a) **Client/Market-related**, which takes into account the following factors:

(i) Long-term commitment of the client to R&D and their willingness to persist with the SRP's research goals in association with the PRO.

This indicates whether the client has a strong R&D orientation and is strongly committed to working together with the PRO in translating the R&D results for eventual commercial benefit.

(ii) End-use growth trends for the eventual product/process considered under the SRP.

If the product or process being developed is applicable to an end-use market that is growing rapidly or has wider ramifications in the market, it brings more visibility and coverage to R&D efforts.

(iii) Potential market impact in India or across the globe on commercialization of the results from SRP.

This factor indicates whether the R&D results make a considerable positive impact on the process/product in terms of increasing its efficiency and thereby reducing the overall processing cost of the product by improving the raw material consumption norms, making the process cleaner, etc.

(b) **IPR/Revenue-related**, which takes into account the following factors:

(i) Possibility of Intellectual Property Rights (IPR) generation from the SRP which will have a marketable value.

In certain cases, intellectual property could emanate from the project, which could have a high opportunity value and bring in additional returns to the PRO.

(ii) Possibility of future royalty or compensation accruable to the PRO upon commercialization of the results from SRP.

A royalty or one-time compensation upon commercialization built into the contract would bring in considerable added revenue over and above the initial contract research fee to the PRO.

(iii) Possibility of licensing the know-how from SRP to other companies after the exclusivity period, thus earning royalties from multi-client sales.

Certain SRPs are undertaken on a non-exclusive basis in view of other considerations; in such cases there are opportunities for multi-client sales and earning revenue from such licensing deals.

(c) **Intangible benefits-related**, which takes into account the following factors:

(i) Expected degree of social impact arising from the outcome of the SRP.

Some SRPs have a high degree of societal impact, leading to some tangible outcomes beneficial to the society at large.

(ii) Opportunity to work with leading companies and possible future SRPs from them.

This indicates whether the SRP, though limited in scope, initially would lead to more opportunities with large companies after the initial confidence-building exercise.

(iii) External visibility that the project outcome is likely to bring to the PRO.

This would indicate whether the outcome of the SRP is likely to make a noticeable impact on the scientific community or industry.

(iv) Learning opportunity provided by the SRP and the ability to creatively apply knowledge resident in SRP to solve a complex problem faced by the industry.

This would reflect whether the SRP would provide an avenue to get into a newer area of knowledge generation with an opportunity to network with other scientific areas.

CONTRACT VALUE INDEX

We have created the term Contract Value Index (CVI) to characterize the ratio of the actual contract fee realized from a SRP to the prevailing man-year rates of the organization. Man-year rates are defined as the sum of costs of a research scientist per man-year, other normal direct expenses per year associated with a SRP, and other organizational overheads per year associated with the PRO. A CVI ratio of 1.0 for a particular SRP implies that the PRO is just breaking even on the SRP. A CVI of greater than 1.0 implies that the PRO has realized a better value due to the opportunity involved, and a CVI of less than 1.0 indicates that the PRO has charged less than the actual costs due to potential long-term benefits. Contract value was normalized to one year in order to compare the data for SRPs with different durations.

RESEARCH METHODOLOGY

Forty contract R&D projects undertaken between 2003 and 2007 at the NCR, a constituent laboratory of the CSIR (India) were identified for this study. Some of them were completed projects and some were ongoing. For the purposes of this study, contract R&D was defined as R&D projects wholly or partially funded by industrial clients having specified R&D objectives and well-defined expected project output, generally but not necessarily culminating in the generation of intellectual property. They included 10 projects in the area of polymers, 8 from organic chemicals and pharmaceuticals, 10 from industrial catalysis, 7 from chemical engineering sciences, 3 from material sciences, and 2 from biotechnology. The number of projects selected from each of these areas was roughly in the same proportion as the industrial revenue earned by NCL from these areas and were also representative of the nature of projects in these areas. The private companies that funded these projects were categorized into Global Multinational Corporations (GMC), Large Indian Companies (LIC) with a turnover above US$ 1.0 billion (Rs.4,000 Crores), and Other Indian Companies (OIC) below an annual turnover of US$ 1.0 billion. Of the 40 projects, 18 were funded by GMC, 7 by LIC, and 15 by OIC.

Computation of PBI

Depending on the perception of a PRO to the above factors vis-à-vis overall organizational objectives, a weight was assigned to each of the factors. In the present exercise, an equal weight of 10% was given to each of these ten factors, which was decided in light of the equal significance attached by the NCL to them. These weights reflect the organizational values and treated as a constant for a given PRO. Each SRP considered for the study was then graded on each of these ten factors using a 4-point scale, assigning a grade of A, B, C or D (High, Medium, Low, or Not Applicable, respectively), which translated into 5, 3, 1 and 0 points, respectively. Thus the maximum possible PBI for any SRP on this scale would be 5, while the minimum PBI would be 0.

Table 1. Computation of Potential Benefits Index (PBI) of Sponsored Research Projects (SRP)

No.	Factor	Grade (A/B/C/D)	Grade Points	PRO Weight	Weighted Score
A	**Client/Market**				
1	Long-term commitment of the client to R&D and their willingness to iterate the research goals from the SRP in association with the PRO	A	5	0.10	0.50
2	End-use growth trends for the eventual product/process considered under the SRP	B	3	0.10	0.30
3	Potential market impact in India or across the globe on commercialization of the results from the SRP	B	3	0.10	0.30
B	**IPR/Revenue**				
4	Possibility of IPR generation from the SRP which will have a marketable value	A	5	0.10	0.50
5	Possibility of future royalty or compensation accruable to the PRO upon commercialization of the results from the SRP	D	0	0.10	0
6	Possibility of licensing the know-how from the SRP to other companies after the exclusivity period and thus earning royalties from multi-client sales	D	0	0.10	0
C	**Intangible Benefits**				
7	Expected degree of social impact arising from the outcome of the SRP	D	0	0.10	0
8	Opportunity to work with leading reputable companies and the possibility of future SRPs from them	A	5	0.10	0.50
9	External visibility that the outcome of the project is likely to bring to the PRO	B	3	0.10	0.30
10	Learning opportunity provided by the SRP and the possibility of networking with other technology areas	A	5	0.10	0.50
	Total Score				

Table 2. Contract Value Index (CVI), Potential Benefits Index (PBI), Research Area and Sponsor Type of Sponsored Research Projects (SRP)

No.	CVI	PBI	Research Area	Sponsor Type
1.	0.22	2.70	ORC	OIC
2.	0.27	1.40	CHE	LIC
3.	0.24	2.60	ORC	OIC
4.	0.65	2.60	POL	LIC
5.	0.64	1.40	CAT	GMC
6.	1.25	2.60	POL	GMC
7.	0.56	0.60	CAT	OIC
8.	0.36	2.10	POL	GMC
9.	2.75	2.30	ORC	GMC
10.	0.17	2.60	ORC	OIC
11.	0.70	2.70	POL	LIC
12.	0.37	1.50	POL	LIC
13.	1.79	2.30	CAT	GMC
14.	2.06	2.70	CAT	LIC
15.	0.58	3.30	MAT	GMC
16.	1.11	3.50	CHE	GMC
17.	0.82	1.80	ORC	OIC
18.	0.52	1.40	CAT	OIC
19.	1.94	2.70	CAT	LIC
20.	1.59	3.50	CAT	GMC
21.	1.23	1.50	ORC	GMC
22.	0.80	1.50	CHE	GMC
23.	0.56	1.20	CHE	LIC
24.	0.53	1.70	ORC	GMC
25.	0.34	1.20	CHE	GMC
26.	0.92	2.50	BIO	OIC
27.	1.22	1.50	CAT	OIC
28.	1.87	2.90	MAT	GMC
29.	0.46	2.70	BIO	OIC
30.	3.64	3.10	CHE	LIC
31.	1.43	1.60	CAT	OIC
32.	0.50	2.80	POL	OIC
33.	2.93	3.00	POL	GMC
34.	0.37	2.70	MAT	OIC
35.	0.90	2.00	CAT	GMC
36.	0.73	0.80	ORC	GMC
37.	0.00	3.20	CHE	OIC
38.	0.28	2.70	POL	OIC
39.	1.59	2.30	POL	GMC
40.	0.96	3.10	POL	GMC

Note: POL=Polymer Sci. & Engr., CAT=Catalysis, ORG=Organic Chemicals & Pharmaceuticals, CHE=Chemical Engr. Sci., MAT=Material Sci., BIO=Biochemical Sci. & Technology, GMC=Global Multinational Corporation, LIC=Large Indian Company, OIC=Other Indian Company.

INTERPRETATION OF THE DATA

Figure 1 shows the data presented in Table 2. The plot was segmented into four quadrants at X=1 and Y=2.5. The value of X=1 was chosen because it represents the break-even point for the funding of any SRP. The value of Y=2.5 was selected because it represents at least 50% of the maximum possible PBI of 5. These co-ordinates were fixed depending upon the NCL's insights into the externally funded industrial projects. The co-ordinates could vary for other PROs depending on their organizational perception.

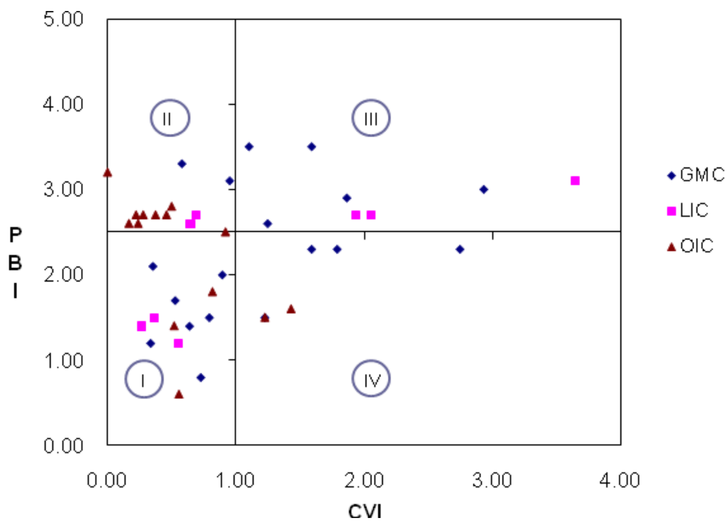

Figure 1. Contract Value Index (CVI) and Potential Benefits Index (PBI) for Sponsored Research Projects (SRP) by Sponsor Type, Quadrants Delineated

The results revealed that nearly one third of the SRPs had a CVI of less than 1.0 and PBI of less than 2.5 as represented in quadrant I (Figure 1). This indicated that such projects were neither attractive in terms of revenue realized nor with respect to any meaningful long-term benefits to the PRO.

About one-third of the SRPs had a CVI of less than 1.0, but a PBI greater than 2.5 as represented in quadrant II (Figure 1). Such SRPs were attractive in terms of their perceived long-term benefits to the PRO, though they initially contributed less to the revenue stream of the institution in absolute terms. In terms of the nature of such SRPs in this quadrant, 75% were from the emerging areas of newer materials, biotechnology and modeling and simulation.

We found that 20% of the SRPs had a CVI greater than 1.0 and PBI greater than 2.5 as represented in quadrant III (Figure 1). Such SRPs were the most desirable because they contributed significantly in terms of both the initial revenue streams and long-term benefits to the institution. Almost all the SRPs in this quadrant were from GMCs and LICs and were in the areas of chemical process development, advanced materials, and novel catalyst systems. It was also determined that such SRPs emerged from the PRO having already done some significant work and filed some patents globally, evincing interest by companies in collaboration and further development.

About 13% of the SRPs had a CVI greater than 1.0 and PBI less than 2.5, as represented in quadrant IV (Figure 1). Such SRPs were attractive to the PRO because they considerably enhanced the income stream of the PRO from non-government sources. However, they were comparatively less attractive in terms of their perceived long-term benefits to the PRO.

CONCLUSION

On the basis of the interpretations provided above, the SRPs could be classified broadly into four categories (Table 3).

Table 3. Classification of Sponsored Research Projects (SRP) with Inferences about Their Benefits and Value and Overall Ability to Generate Future Revenues

Quadrant	Inference	Classification
I	These are more routine SRPs and do not add long-term value to the PRO. Financially, they are not very rewarding.	Move away
II	These SRPs may have lower financial gains initially, but their long-term benefit potential to the PRO is very high. Such SRPs are normally in the emerging areas.	Futuristic
III	These SRPs have a high level of perceived long-term benefits and bring in substantial revenues upfront to the PRO.	Desirable
IV	These SRPs are cash cows. Though the perceived long-term benefits may be fewer, they are a source of substantial revenue for the PRO.	Beneficial

Any PRO should have an optimum combination of projects in quadrants II, III, and IV to realize the goal of enhancing revenue from non-government sources and also to add value to the organization in the long run. Too many projects in quadrant IV would be financially beneficial to the PRO in the short term but would be detrimental in the long run. Similarly, a concentration of projects in quadrant II might benefit the PRO in the long run with fewer short-term financial gains, but the nature of futuristic and exploratory projects undertaken under this domain would make long-term returns rather unpredictable. Quadrant III projects are the most desirable for PROs, but to attract such projects it is essential that the PRO do considerable work upfront and file patents in that area to be able to attract substantial funding. To the extent possible, PROs should move away from quadrant I projects because they do not benefit the organization in any way.

Utility and Limitations of the Model

An analysis of the portfolio of SRPs undertaken in any PRO on the above basis would throw some light on the character of SRPs undertaken and where the PRO is heading in terms of its value creation from undertaking such industrial projects. Corrective action could then be taken over a period of time to ensure an optimum combination of projects in each quadrant so as to maximize the long-term returns to the organization under the constraints of limited available organizational resources. The model enables a PRO to make a preliminary judgment on a SRP before undertaking it and decide whether it fits into the overall organizational strategy at that point in time. It also overcomes the personal biases associated with selecting prospective R&D partners and would enable a PRO to make an upfront assessment of whether to undertake a SRP when the PRO is faced with multiple project opportunities from different companies. This helps in the introspection of the SRPs undertaken across different disciplines and to re-align the portfolio of SRPs to suit the immediate and long-term interests of the PRO. See Figures 2-4, for example.

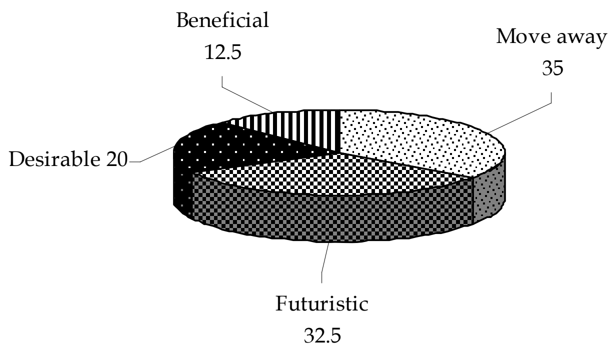

Figure 2. Percentage of Sponsored Research Projects (SRP) by Classification Undertaken at National Chemical Laboratory (NCL), 2003–2007

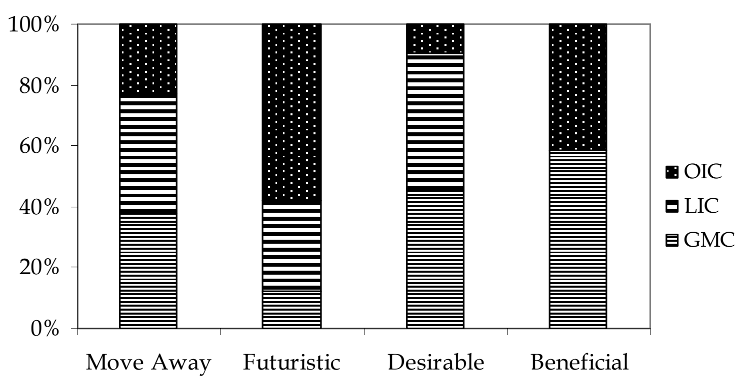

Figure 3. Distribution of Sponsored Research Projects (SRP) by Classification and Sponsor Type

Note: GMC=Global Multinational Corporation, LIC=Large Indian Company, OIC=Other Indian Company.

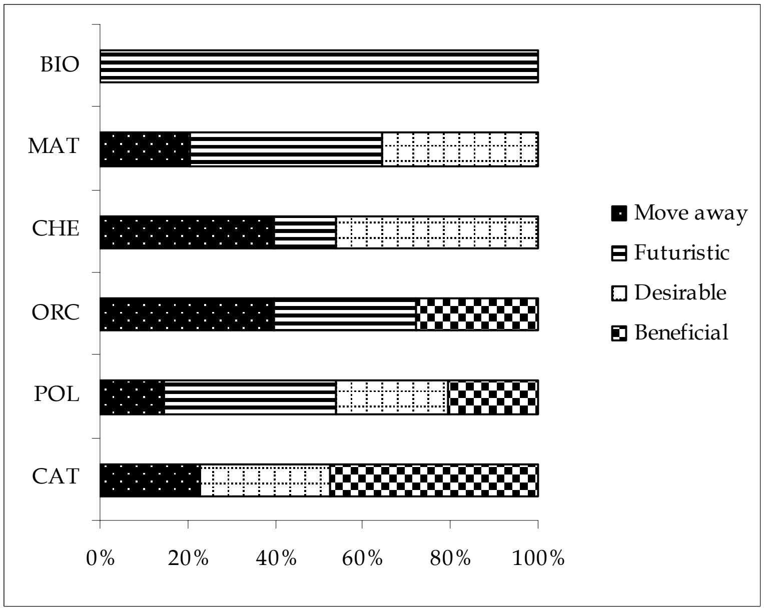

Figure 4. Distribution of Sponsored Research Projects (SRP) by Research Area and Classification

Note: POL=Polymer Sci. & Engr., CAT=Catalysis, ORG=Organic Chemicals & Pharmaceuticals, CHE=Chemical Engr. Sci., MAT=Material Sci., BIO=Biochemical Sci. & Technology

Apart from the PROs, this model can be applied to other organizations, such as academic institutions, where the necessary factors for PBI computation may be tailored to organizational policies. It is necessary to emphasize at this juncture that one of the criteria in developing this model was simplicity and ease-of-use in practical applications. We sought not to clutter the model with a large number of parameters that would have turned this into an academic exercise with no real-life application.

One of the basic limitations of the model is that the determination of PBI is subjective. Therefore, it is essential to determine PBI in association with a team of organizational experts knowledgeable in the areas of technology, business, and intellectual property management. Similarly, different organizations may attach different weights to the various factors involved in the computation of PBI, so an inter-organizational comparison with this model may be inaccurate. Nevertheless, the model is useful in evaluating the various determinants that contribute to the long-term benefits to a PRO from sponsored research projects. Greater use of this model by the PRO will lead to further refinements, resulting in more quantitative assessments of the value of SRPs undertaken by the PRO.

ACKNOWLEDGMENTS

The authors would like to thank Dr. S. Sivaram, Director, National Chemical Laboratory, Pune, India for his encouragement and support to the fundamental idea behind this concept.

ENDNOTES

1. For this and additional information, please visit the Council of Scientific and Industrial Research website at: http://www.csir.res.in.

2. Guidelines for Technology Transfer and Utilization of Knowledgebase, Technology Networking and Business Development division, CSIR.

3. For this and additional information, please visit the National Chemical Laboratory website at: http://www.ncl.res.in.

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Book Review

Successful Grant Writing: Strategies for Health and Human Service Professionals (3rd ed.)

Laura N. Gitlin and Kevin J. Lyons
Springer Publishing Company, 2008
ISBN: 978-0-8261-3273-4. $45.00. 401 pp.

As university research administrators, we sometimes wonder why the grant proposal submission process, which is relatively straightforward and about which faculty members seek support, can be so problematic for accomplished researchers. In this context, the third edition of this popular book by Laura Gitlin and Kevin Lyons provides insights not only into the development of a grant proposal, but how this activity fits within faculty members' career progression in the university setting.

Both authors are highly qualified scholars, researchers, and administrators with Thomas Jefferson University's Jefferson College of Health Professions. Dr. Gitlin, founding director of the Center for Applied Research on Aging and Health, has led or collaborated on over $25 million in funded projects, published widely in books and peer-reviewed journals, and serves on grant review panels. Dr. Lyons, Associate Dean of the Jefferson Colleges of Health Professions and of Graduate Studies, has likewise served on many advisory boards and review panels, and consults on research development. Therefore, both are appropriate sources of advice on grant writing and on tracking the national trends that affect success in the external funding arena.

The new edition builds on the grant-writing "how-tos" of previous editions. However, chapters have been re-organized to accommodate new and expanded information on budget development and management, cross-disciplinary and translational research, and post-award administration. Thus, this book is far more than a manual for achieving grant-writing success. Many of the issues addressed in other grant-writing publications, such as how to find an appropriate funder, details of the writing process, and crafting a budget appropriate to a funding request, are presented. In addition, the grant proposal development process is framed as just one component in developing a successful academic career. The authors discuss the many functions, in addition to receiving funding, which are served in writing a grant proposal. The proposed model for a "Research Career Trajectory" takes the faculty member through a four-stage process (*novice, intermediate, advanced*, and *expert*) with appropriate levels of activities that might occur at each stage. For example, a *novice* will identify an area of research focus, refine that area at the *intermediate* stage; as an *advanced* researcher actively engage in broadening the research scope; and as an *expert* actively engage in a larger-scale program. Similarly, the *novice* might apply for small intramural research support for a pilot study; request funds at the *intermediate* level from professional associations or small foundations; submit proposals to larger foundations and small grants mechanisms in the National Institutes of Health (NIH) as an *advanced* researcher; and finally seek large National Science Foundation (NSF) or NIH grants at the *expert* stage of his or her career.

The reader explores many aspects of the grants process through seven major sections. The first, "Getting Started", presents the story of a new assistant professor who has a project she would like to initiate but for which there are few resources. The same thread is picked up at various stages throughout the book as this researcher finds an appropriate funding source and collaborators and develops a proposal. Because the target audience, health and human service professionals, often does not have training in basic grant-writing skills, the book proceeds in stepwise fashion. As part of "Getting Started" we learn how to fit grant writing into overall career goals, the process of becoming familiar with funders, how to determine if a particular grant program is right for the proposed research, and how to modify and expand an idea so that it is appropriate for a particular funding source.

Part 2 describes the writing process and includes the most frequently required sections of several different proposal types with tips on how to organize the writing process and avoid writer's block. The reader is provided with a detailed blueprint for writing a concept paper and the importance of doing a needs assessment and pilot studies. Also covered in this section are such supportive elements as letters of support and formal written agreements between collaborators. Part 3 gives instruction on and examples of developing a budget and justification. Budgetary information on, for example, the use of a modular budget by the NIH, is provided.

Part 4 moves from an applied approach to grant writing to a more theoretical discussion of different models of proposal development. According to the authors, simple frameworks include the *individual* model (one researcher working alone) or a *consultative* arrangement (one junior faculty member mentored by one or more individuals who are more experienced or have specific skills required for the project). More complex models described are *cooperative* interactions, in which those from different disciplines or with different skill sets work on a common project, each applying their own discipline to one aspect of a problem. The *collaborative* model requires a more integrated team approach characterized by cooperative idea development and problem solving. Because funding agencies now encourage and are more likely to fund multidisciplinary projects, this section is very important to understanding how to put a team together and nurture that interaction.

Part 5 takes the reader back to the practical, with a discussion of what the grant writer needs to know about the institution's rules pertaining to proposals and the electronic submission process. Part 6 focuses on the proposal review, including how different funders conduct the review process and whether and how to respond to a grant review. This section ends with an example of a proposal submission and its review. The book concludes with a section on grants management issues post-award.

Anther strength of the book is the inclusion of text boxes that provide information on, for example, "Skills of Funded Veteran Researchers" (p. 27) and "Barriers to Conducting Funded Research" (p. 29). The book is very easy to follow and gives basic information applicable not only to heath and human services faculty but also to other disciplines. Although of some interest to those outside the academic setting, the information presented is most applicable to universities and their faculty. Likewise, although it may not be of much help to experienced researchers, it is a good resource for mentors who may not remember the grant submission learning curve they experienced early in their careers.

As a reader, I did identify a number of small editing errors; the book could have used one more round of proofing to locate disconnects between the text descriptors, summary text boxes, and figures. It is always difficult to decide on the appropriate order in which to present topics, especially in a major revision for a new edition. I also found that the more theoretical discussion of collaborative models broke up the stepwise description of proposal development. This section would be more appropriate in the initial "Getting Started" section or at the back as an appendix. There was also notable repetition of concepts throughout the book, with a description of the same points and skills across several chapters. Although distracting to a reader digesting the book from cover to cover, this is not necessarily a bad approach if the book is to be used as a reference for specific topics (e.g. how to write letters of support).

Several aspects of this book make it an excellent resource for research administrators. For those of us who conduct proposal development workshops, it provides a great framework for presenting important information to faculty members, and numerous places appropriate to inserting rules and resources for each individual organization. It also highlights the role of the university research administrator in many sections, with suggestions and/or recommendations to the reader to consult their university's research or sponsored programs office at numerous points in the proposal development process. By providing an overall description of how writing and submitting grant proposals fits with faculty members' many other career obligations, it provides a perspective on this group's professional life. In providing research administrators a chance to stand in faculty members' shoes, the authors help bridge the gap between the different professional cultures.

This book will be a valuable addition to the bookshelves of research administrators, health and human services professionals, junior faculty members from a variety of disciplines, and those who mentor early career researchers.

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Fred Tudiver is Professor of Family Medicine and Director for Primary Care Research at the Department of Family Medicine, James H. Quillen College of Medicine, East Tennessee State University. He is an active family physician and primary care researcher. His research interests are in the areas of changing physician behavior, evidence-based medicine, especially at the point-of-care, and primary care mental health. In the early 1990s he and four co-editors published a seminal 6-volume book series on research in primary care.

Shweta Uttam has more than 15 years of experience in the areas of R&D management, technical services and systems analysis with leading private and public institutions in India. She is currently working at the interface of technology and business to generate market opportunities for commercializing R&D results in highly knowledge-intensive areas. She holds a B.Tech. degree in Chemical Engineering from A.C Tech, Chennai, India; a Post Graduate Diploma in Intellectual Property Management from NALSAR, Hyderabad; and an MBA degree in Finance.

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