

The State of Practice for University Technology Transfer Activities

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Abstract

In this paper, we review findings and issues that emerge from our on-going, multi-part study of university patent and licensing activities. The study has involved national surveys of university technology transfer offices as well as detailed case histories at Duke University (Duke), Johns Hopkins University (JHU), and Pennsylvania State University (PSU). We offer it as a form of collective return to university officials for their cooperation and investments of time and efforts on our group's behalf.

Introduction

If imitation is the sincerest form of flattery, then the number of surveys a group is asked to complete measures societal interest. By this standard, university technology transfer offices (TTOs) and the individuals who staff them are clearly important. Certainly they are to the several academic researchers who have filled the postal and electronic mailboxes and telephone phone lines of university technology transfer offices in recent years with questionnaires of one form or another, and to which TTO officials have graciously responded.

The surveys represent heightened scholarly and policy interest in the structures, strategies, and behaviors of university technology transfer offices. Motivating this interest is the growing realization—obvious perhaps to TTO officials, but frequently muted if not ignored in larger national policy and research studies—that the relationships between (1) broad national, state, and university policy changes designed to foster academic patenting, technology transfer, and the commercialization of academic research, and (2) the observed outcomes, as typically measured and reported in Association of University Technology Managers (AUTM) and the National Science Foundation (NSF) statistics, are influenced and mediated by what does and does not occur in TTOs. AUTM and NSF data, and, indeed at times universities in their own reports of accomplishments, provide limited insight into the myriad of organizational, policy, and strategy decisions that exist between a faculty member's pursuit of a research project and a measurable impact on intellectual property or technological innovation. To cite Bayh-Dole or the 1981 Chakrabarty decisions as explanatory factors for what is now a two-decade rise in academic patenting and licensing is the beginning, not the end, of analysis.

Recently, we and other academic researchers, such as Mowery, Nelson, Sampat, and Ziedonis (1999), Rogers, Yin, and Hoffman (2000), Thursby, Jensen, and Thursby (2001), and Siegel, Waldman, and Link (1999) have sought to go inside the “black box” of university technology transfer offices. Collectively, this research has drawn heavily from the concepts and methods of economics and organizational behavior; thus, research interest has focused on topics such as efficiency, organizational design, strategy, and technology transfer survey-based studies by researchers. Collectively, too, the research has been based heavily on surveys of TTO offices.

This review focuses on three themes that have been central to our research to date: (1) the organization, objectives, and strategies of TTOs; (2) institutional strategies; and (3) trends towards acceptance of equity

as a means of payment for university intellectual property rights. We close with some observations about both inherent, unresolved issues and newer, emerging issues emerging from institutional successes in getting faculty to patent as well as to publish.

The central conclusion emerging from our research is that the structure and strategy of technology licensing offices are key variables in explaining aggregate relationships between variables, such as the level and composition of a university's R&D portfolio, and its patent and intellectual property rights performance. This finding does more than state that TTOs are doing their jobs, and, implicitly, that some may be doing their job more effectively than others. Viewed from selected analytical and policy perspectives, our findings raise several new questions about the behaviors of TTOs, while preliminary answers to the questions provide new insights into the whys and wherefores of performance differences among universities. The findings also provide new insights into what we perceive to be the dynamic evolution of learning in universities and TTOs; this learning, in turn, accounts in our view for the frequent changes in organizational structure and strategy (as well as times of personnel) in the universities we have studied in detail, and which we believe to also be frequently found in other institutions.

As one example, our findings call into question the efficiency of benchmarking, a technique widely used by universities to gauge the performance of their TTOs. Organizational arrangements may cause an institution to be measuring the wrong output and outcome variables. A university, for example, that organizationally bifurcates reporting as well as responsibility between an office of sponsored research and a patent foundation but finds that the largest monetary return it can get for its patents is through “leveraging” the amount of sponsored research it obtains from firms may appear to be “underperforming” relative to benchmarked institutions, yet the outcomes may be consistent with the objectives of central administrators, faculty, and the TTO (Feller, Feldman, Bercovitz, and Burton, 2000). Most importantly, our work suggests that beneath the optimism and self-congratulatory tones in which universities singly and collectively report trends towards increased numbers of patents, licenses, and aggregate intellectual property rights income, they are still searching for an effective and efficient set of strategies and organizational arrangements consistent with university objectives.

Organizational Trends

Universities must organize themselves to promote and process invention disclosures and to sift through disclosures to determine those for which patents can or should be filed. In establishing a TTO, they must set objectives and resources, hopefully in reasoned relationship to one another. They must establish reporting relationships for the TTO and fit its activities into those of other university offices that have related responsibilities, such as sponsored research programs, industrial liaison, and corporate development. Within the context of its reporting relationships, mission, objectives, and resources, TTOs, working with the guidelines of legislatively or institutionally initiated policies, must determine the strategy for promoting the use of the university's intellectual property, including the forms in which it will seek revenue from these assets.

Increases in the number of universities with TTOs and in the size (by personnel and operating budgets) of these offices have been one of the dominant characteristics of university responses to the Bayh-Dole period (Rogers, Yin, and Hoffman, 2000; Thursby, Jensen, and Thursby, 2001).¹ This increase has been associated with organizational change and change in strategy. Our work points to an almost 15-year period of on-going and continuing adjustments in university arrangements of TTOs. These changes reflect institutional assessments of recurrent performance gaps, generated either internally by administrative or faculty dissatisfaction with performance of an existing TTO structure or externally via performance gaps identified through various benchmarking or anecdotal accounts of higher levels of outcome from institutions defined as “peers.”

Universities have been engaged in an on-going search for the right combination of organizational structure, such as reporting relationships, strategy, and personnel, including here the size of staff, the mix of talents, and identification of effective leaders. This search has not been a one-time event; rather, as suggested by

our work and that of others, the process is a continuing one. In some cases, the changes are produced by outright dissatisfaction with the performance of a TTO on the part of university administrators and faculty, and to a degree by the firms with whom a university was seeking to enter into agreements. More recently, as individual institutional experience accumulates and as collective measures and reports of experiences elsewhere are collected and disseminated, dissatisfaction takes the form of a perception that the institution is not doing as well as it could (gauged frequently in terms of benchmarking comparisons with like institutions).

Institutional histories of the on-going evolution of TTOs tend at times to center about personalities, and indeed our work does suggest that the inauguration of a new university president is often a time for stocktaking of a university's intellectual property rights performance (as it is of other aspects of the institution's performance), followed at times by major changes in organizational structure and/or TTO personnel (Matkin, 1990).

Still, our research suggests several structural features shape the dynamics of organizational change. Briefly, a TTO's effectiveness (and thus in part the university's overall performance in measures of patenting and licensing) depends on (1) its ability to coordinate its activities with those of several other work units, such as sponsored research, corporate giving, and industrial liaison; (2) its ability to process, that is, to receive, interpret, synthesize, and disseminate information both within and without the university; and (3) an effective alignment of incentives between and among the TTO, faculty, and administrative units.

Drawing on studies of the evolution of the modern business enterprise, we further suggest that different types of organizational forms—say among a centralized, functionally departmentalized structure in which decision-making and coordination responsibilities lie with a small group of top executives, a multidivisional form organized into semi-autonomous divisions operating along customer, product, or geographic lines, and a matrix organization—differ in the extent to which they foster one or more of these performance attributes. An institution's ability, for example, to manage the trade-off between a royalty rate/licensing fees and sponsored research dollars will be greater where there is a matrix form of organization that links an office of intellectual property and a sponsored research organization than where the units are organized in the form of a holding company. In the latter case, each unit is left to pursue a self-defined maximizing strategy, focusing respectively and independently, on intellectual property income or sponsored research support.

The effort to find the right organizational form that yields effective performance in terms of coordination and information processing and is consistent with the set of incentives that the university has set for faculty academic units and the TTO accounts, we believe, for both the evolutionary histories and the current differences that exist in the structures of the TTOs at Duke, JHU, and PSU—the three institutions we have studied in detail.

Our work at these three institutions, coupled with findings from a national survey of other Research I and II universities, also points to a trend towards selective decentralization of TTOs in the direction of providing services to academic units (and locations) with substantial external research activity, especially in fields where patents, licenses, and spin-off opportunities appear plentiful. This has been most evident in providing separate offices for a university's medical school. The pattern is evident at Duke, JHU, and PSU. At Duke, the technology licensing office is administratively housed in the medical center, which is responsible for the larger percentage of the university's external R&D as well as patents and licenses. At both JHU and PSU, new TTO units have been established to accommodate the rising volume of patents at each institution's medical school.

Strategy

Our interviews suggest that universities are increasingly viewing their patent and licensing activities as part of a portfolio of interactions with selected firms and industries. Thus rather than seeking maximum gains from one-time transactions limited to intellectual property rights, TTOs may be participants in a broader,

more strategic endeavor by the university involving several offices, to maximize long-term, multi-faceted relationships. Thus corporate gifts, increased sponsored research agreements, and discounts on equipment purchases are each economic tokens of the exchange relationship, including goodwill, that exists between a firm and an institution. A university's interest would appear to be to maximize this goodwill and thus the total quantity of economic tokens, not simply the returns from any single patent.

Viewing TTO activities in this broader, longer-term light serves to raise questions about the validity of conventional benchmarking activities, and the heavy reliance that universities appear to be placing on comparative measures to gauge performance or allocate resources. If universities follow different strategies in securing revenues from intellectual property rights, say systematically preferring "leveraged" industrial R&D support or other forms of corporate support in lieu of license income (or accept lower royalty rates for increased funding), then using aspects of license agreements (say total license revenues or license revenues per TTO FTE) can be misleading. Intentionally or not, benchmarking may compress institutional strategies into fewer options, thereby reducing its flexibility to capitalize on its distinctive niches or singular opportunities. Phrased differently, reliance on benchmarking measures without prior assessment of underlying strategies may drive institutions to courses of action inconsistent with their objectives and set of feasible choices.

Equity as Compensation for Intellectual Property

In the years immediately following Bayh-Dole, with the exception of a few institutions such as MIT, most universities eschewed equity, accepting it primarily in those cases where they believed that they had a patent that had economic value but for which they could not attract a buyer willing to pay upfront fees or negotiate running royalties. For this reason, university holdings of equity became associated with start-up firms. This outlook has changed, as have universities' negotiating strategies.

In summer 2000, we conducted a survey of the 124 Carnegie I and II research universities that have active technology transfer operations, and received 67 responses (54%). Our findings document the increasing willingness of universities to seek and/or accept equity as a form of payment for access to patents. The universities in our sample reported participating in 679 deals. The distribution of participation was highly skewed. The mean number of equity transactions was 10, the median was 5, and the mode (n=16) was zero. The maximum number of equity deals was 90. The number of new deals per year has increased almost steadily since the mid-1980s.

Together, the combination of the skewness of the data on total number of deals, the number of universities reporting no equity, and the increase in the number of deals per year reported by those taking equity, suggests that considerable time may be required to overcome institutional opposition to an equity stance, as well as for public universities at least, state constitutional and legislative prohibitions. However, once these barriers have been removed or bypassed, universities begin to treat equity as part of a general, although still modest part of their intellectual property rights portfolio.

Our interviews with TTO officials indicate that this increase reflects several factors. Overall, there has been a shift in the expectations of TTOs concerning equity; they now see it on some occasions as having a higher expected value than license and royalty income. This shift, in turn, derives from several factors. In part, it comes from what we would suggest is growing disappointment with their growing number of licenses—in conventional TTO parlance, few home runs, a number of singles, and clearly a number of strike-outs. Equity not only is seen as having a higher upside value than license income, but it also provides the university with a stake in the economic well-being (and revenues) of the entire firm, not simply the technology in which the university holds a patent. This arrangement may be particularly appealing when the prospective acquirer of the university technology is an established, albeit likely modest-sized multi-product firm. (This strategic consideration also leads to a shift from having equity employed only in the case of a spin-off or start-up firm, where the firm lacks the capital to pay upfront fees or running royalties, at least in the early years of an agreement, to more established firms.)

Equity was also seen by TTOs as a better means (relative to licensing) for aligning the long-term interests of the university and the firm. Equity is viewed as producing common goals towards promoting the commercialization of the technology and the increased capital value of the firm. As we have written elsewhere, "With equity, both parties gain as the total value of the licensed technology, as well as the firm as a whole increases. As such, it is in the best interest of both parties to take actions that enhance the probability of the firm's commercial success" (Feldman et al., op. cit.).

Equity-based licenses are also seen as easier to write and maintain because once initial terms are agreed upon, they must deal with fewer contingencies. An equity-based agreement, in effect, changes the locus of a contract from price and performance to agreement on ownership shares. One positive perceived side-effect of this change in locus is the reduced potential for litigation. For example, there is less likelihood for conflicts about the extent to which the university's patent is used in the development and evolution of a commercially viable product. Under a license agreement, this may be a recurrent point of contention; with equity, according to this perspective, the university's interest is protected by its claim against the firm's rising revenues.

Finally, equity is seen as providing legitimacy and prestige for both the firms and the university. Firms believe that having the university as a part-owner increases its credibility as it seeks to raise capital or market a new product. For the university, equity holdings contribute to its reputation as a source of commercially valuable technology, as an entrepreneurial institution, as a compelling (and at times coercive) motivation for public universities, and as responsive to state government expectations that it serve as an engine of state and regional economic growth.

TTO officials did note that downside risks beyond the uncertainties associated with revenues existed with taking an equity position in a firm, established or start-up. Concern was voiced that when the university takes an ownership position, it also may become liable if any untoward event were to occur involving the firm. The legal question of the character of this liability risk is unclear, as is its possible financial magnitude. Still, interviews indicate that some universities treat liability as a serious risk, and are therefore cautious about taking equity.

Emerging Issues

Increased Patent Disclosures

A sorcerer's apprentice syndrome may now be hitting universities. Changes in university policies and norms that have fostered the pursuit of patents by faculty coupled with the promotional and educational efforts of university administrators and TTOs have encouraged faculty to view their research as a potential source of patents, and as potential sources of income to the institution, their department or laboratory, and themselves. Faculty members have responded by submitting increasing numbers of inventions disclosures. Universities must now deal with this rising flow.

Within increased but still constrained budgets for filing patents and managing licenses, universities must sift through these disclosures to separate first those that are patentable, and second, those with commercial value. This is no an easy task; to manage it effectively requires both technical and economic knowledge. To acquire this expertise, whether in-house or through reliance on outside sources, entails resources leading to upward expenditure pressures on a university's minimum outlays for patent and licensing activities if it is to garner benefits from its research.

The well-known complexity of these tasks is heightened by the fact that these decisions involve more than technical and economic uncertainty; they involve institutional and personal relationships among faculty and the administrators and possibly faculty that make up internal review boards to determine whether the next steps towards filing provisional or full patents should be taken once an invention disclosure is filed, or how much of a TTO's time and effort should go toward seeking a licensee for a particular patent. This is not a simple matter. It is not easy to decide not to proceed further towards patenting when the inventor is a

distinguished faculty member, perhaps operating a major, externally well-funded research laboratory. Refusing to do so risks alienating influential faculty, and calling into question the responsiveness of the TTO to faculty interests. Acquiescing to these internal considerations, however, can cause a university to invest in a lot of dry wells.

Equity Holdings

Future trends in university acceptance of equity are also problematic. The rationales offered are for increased university willingness to accept equity represent ex ante, or anticipated economic, contractual, and reputational benefits. In this respect, they are akin to university investments in research parks: optimistic projections and mixed outcomes.

Given recent trends and the seeming continuing lure of home-run gains from intellectual property office (IPO) issuances, it is likely that the absolute number of equity deals will increase and that more universities will take equity. Such a development, however, may primarily reflect the growth in the total number of transactions and the loosening of institutional (and state legislative) barriers towards accepting equity as the practice increasingly is seen (or presented) as the norm. In effect, we may be observing the “take-off” phase of equity transactions, as more institutions experiment with the technique and as several recent experimenters increase their consumption of the new (to them at least) product. What the “steady-state” role of equity is in a university’s total intellectual property rights strategy portfolio is less apparent.

Equity does involve an opportunity cost: the loss of the more certain license, upfront fees, and sponsored research support. It seems evident that the rise of equity holdings was linked to the exuberant market for start-up firms of the recent past. The amount of dead founders’ stock in the hands of universities or their arms-length foundations following the recent sharp downturn in the stock market is not known, as it is not the type of statistic readily highlighted in university annual reports.

The cyclical volatility of venture capital funds—a decline of 61 percent on an annual basis in the second quarter of 2001—also may be sobering. Venture capital and the buoyancy of the initial placements markets are key factors in determining the effectiveness of the equity strategy as it permits an institution to cash in on its founders’ stock. Little evidence exists as yet as to whether universities are “patient” or “inpatient” investors, and, relatedly, to turn to our discussion of organizational and strategic elements, whether cash flow considerations, namely the need in many institutions for TTOs to self-finance all or part of their operations from intellectual property rights assets, will constrain their longer-term ability to employ the equity strategy to a sizeable extent.

Certainly, though, one would expect (or more pointedly, hope) that the entrepreneurial spirit about the prospects of economic gains from capitalizing through equity on the value contained within a university-based patent that permeates university leaders and TTO officials would be somewhat chastened, as for investors more generally, by the precipitous stock market decline, especially in the technology sector.

Reassessment of the Post-Bayh-Dole Era

Rising annual totals in patents, license income, start-up firms, and the several sets of statistics employed to trumpet the “new” or “increased” contribution of universities and academic research to technological innovation and economic growth may seem to make reexamination of the impacts of Bayh-Dole and the world it is widely stated to have wrought as quixotic endeavors or “academic” noise. Why question the obvious? Yet serious scholarly calls have begun to be made for a reexamination of the tendency by universities (and TTOs) to associate these statistics with increases in the net contributions they make to technological innovation.

This critique extends beyond, although it at times encompasses more well-known normative concerns about the impacts of assertive patenting and commercialization activities by universities on historic institutional

missions, the distortion of institutional priorities between revenue and non-revenue-generating forms of research, and the open exchange of scientific knowledge. Rather, it is directed at the core analytical and empirical tenets of Bayh-Dole, namely that the Act and associated legislative, organizational, and policy changes have been the primary causes of the manifest upward movement in patent, licensing, and associated revenue streams.

The critique is found most notably in the works of Nathan Rosenberg and Richard Nelson and their colleagues (Feller, 1997; Mowery and Rosenberg, 1989; Nelson, 2001; Nelson and Rosenberg, 1994). It is based in part on an examination of the historical “record of strong performance in doing research than contributed to technical progress and industrial development and strong efforts in technology transfer” prior to Bayh-Dole (Nelson, 2001, p. 17). In part, too, it is based on data from Columbia University, Stanford University, and the University of California System that indicate upward trends in patenting and revenue prior to Bayh-Dole. These trends were related to the distinctive role of these (and other) universities as sources of new scientific knowledge for which both the technological applications and commercial potential were readily discernible. Moreover, industry was keenly aware of the research being conducted at these institutions. In Nelson's words, “The activities of the university technology transfer offices, therefore, basically amounted to trying to collect revenues from companies that already were using the technique” (Ibid., p. 16).

Finally, the critique raises as a question to be answered the net contribution of new university initiatives, including here the activities of TTOs, to technology transfer and technological innovation. As suggested by the above statements, some portion of the gross knowledge transfer activities now occurring in the form of patents and licenses would likely have taken place in the absence of Bayh-Dole, TTOs, and patents; the unanswered (but also in good part unasked) question here being both the difference in rate and level of difference and the distribution of the economic benefits of various modes of transfer. But besides this subtraction of what would have likely happened in the absence of the post-1980 regime is the apparent need to subtract the loss of knowledge transfer arising from university patent and licensing efforts.

Clashes between universities and firms about patent rights, such as those recently involving Columbia University, University of Rochester, and most notably the Wisconsin Alumni Research Fund's claim to a core stem cell research patent, point to increased competition and divergence of interests arising out of the newly assertive intellectual property stances of universities. These comments are not to suggest that the universities are behaving inappropriately or unwisely in their pursuit of patents and the revenues that may be generated by them. Rather, it is to suggest that trade-offs likely exist between aggressive pursuit of intellectual property rights revenues and other forms of revenue that universities have historically sought and received from industry. A major pharmaceutical company that loses a heatedly contested patent case against a university and subsequently finds itself having to pay license royalties, possibly on a non-exclusive license, would appear to be a less responsive contributor to a capital development campaign.

Conclusion

Our review highlights continuing learning and change in the organizational structures and strategies of technology transfer offices at American universities, designed to improve effectiveness and efficiency. The changes emerge from a mix of dissatisfaction with existing arrangements (underperformance) and a perception of unrealized opportunities (underachievement). However, even as they deal with organizational and strategic issues, universities singly and collectively must deal with the consequences of incomplete success—increasing patent and licensing activity but marginal net revenues for all but a handful of universities—and continuing questioning about the magnitude of the net benefits from all of this effort. We offer here no predications about what institutions will or should do. What we do see is the likelihood that the issues identified in this paper will come to the fore in the near future, as TTOs, universities, and external constituencies seek to compute the net benefits from recent trends in increased academic patenting and licensing.

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Note

¹ Bayh-Dole is used here as a convenient shorthand to summarize the several factors that have been identified as leading to increased university attention to their intellectual property rights and as underpinning the statistics presented in AUTM and related surveys. Recent work by Mowery et al. and Nelson (2001) highlights the rise in patent and licensing activity, and the concentration of academic patents and license revenues in biomedical fields, broadly defined, at selected major research universities prior to 1980.

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