# Academic Capitalism and University Incentives for Faculty Entrepreneurship

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ABSTRACT. Entrepreneurial behavior by professors—including decisions about collaboration with industry, patenting and spinning off companies—can affect the productivity of top universities' technology transfer efforts. Interviews with 98 professors at 12 southeastern universities showed that the most significant influence on these aspects of entrepreneurial behavior is the beliefs of professors about the proper role of universities in the dissemination of knowledge. Some institutional policies, notably revenue splits with inventors, can affect aspects of this behavior. These findings suggest that both university incentive policies and ethical concerns about academic capitalism, by limiting the productivity of technology transfer efforts, have an effect on regional economic development.

**JEL Classification:** L31, L33, O31, O32

## 1. Introduction

Faculty researchers are making key decisions that affect the outcome of the technology transfer process and thereby have an impact on regional economic development. These decisions include: (1) what industrial collaboration to seek; (2) whether or not to disclose their discoveries and whether or not to patent them; and (3) whether or not to spin off a company. If we could better understand what influences these decisions, we would expect that technology transfer productivity could be improved which would, in turn, increase the universities' regional economic impact.

Past research has focused on the economic and institutional influences on university behavior, particularly with regard to spillovers. This economics-based research literature has looked at the role of the university in local and regional economic development. Rational choice institutional approaches have been used to describe the changes in universities since the enactment of the Bayh-Dole Act in 1980 which accelerated the technology transfer transformation of universities.

This paper expands the academic literature by considering the behavioral characteristics of the individual professor. Understanding the motivations of the professors who are performing the research and making decisions about whether or not to protect the resulting intellectual property could give policymakers additional information that could be useful for designing interventions that will increase the productivity of the technology transfer process and hence the resulting economic development.

Universities contribute to regional economic development in many ways. Goldstein and Luger (1997) characterize the university as a multi-product entity that effects regional economic development in eight ways. Most relevant in the context of this paper is that new knowledge is explicitly transferred to industry through the formal technology transfer process; some knowledge is applied to the creation of new products and processes and some to the improvement of existing products and processes.

The research university has changed dramatically during the past 20 years with regard to its attitudes about technology transfer (Feller, 1997b). Four events in 1980 precipitated this change, often referred to as the second transformation of the university (Etzkowitz, 1983). These events were the decline in Federal funding to universities, the Bayh-Dole Act of 1980, the emergence of biotechnology, and the Supreme Court decision in *Diamond* v.*Chakrabarty*.

Federal funding for university research declined in 1980 to only two-thirds of academic R&D funding, down from a high of 73% in the mid-1960s. By 1997, that share had dropped to

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59% and has remained between 59 and 60% ever since (National Science Board, 2000).

Observers have argued that this decline in funding caused universities to turn toward industrial funding sources and that the increased dependence on private sector resources caused the universities to change to be more like the private sector (Hackett, 1990). This resource dependence explanation, however, fails to take into account the fact that many universities had previously gone through periods of varying dependence upon industry funding for R&D (Lowen, 1991; Mowery and Rosenberg, 1998).

Bayh-Dole was enacted to "promote the utilization of inventions arising from federally supported research ... [and] to support the commercialization and public availability of inventions" [35 U.S.C. 200]. The Act created, among other things, a uniform patent policy for federal agencies and enabled small businesses and universities to retain title to inventions made through federally-funded research. The effects of the Bayh-Dole Act on university patenting activity have been widely documented. The number of patents granted to universities has risen sharply (Henderson *et al.*, 1998) and the number of universities patenting rose with an attendant learning effect as new entrants became more proficient at patenting higher-quality inventions (Mowery *et al.*, 2002).

Genentech, the first biotechnology company and a spin-off from Stanford University and the University of California at San Francisco, went public in 1980. Based on two technologies, recombinant DNA (Dueker, 1997) and monoclonal antibodies (U.S. Congress, 1984), biotechnology knowledge is basically process technology, a new way of making certain substances or producing certain antibodies in quantity. To transfer this knowledge, which is not easily written down, requires collaboration in the laboratory between the inventor and the learner, usually industry (Pisano *et al.*, 1988). This reliance on collaboration in biotechnology is shown by the relationships between university researchers and new biotechnology firms. Spin-off companies are the norm for the industry (Kenney, 1986; Zucker *et al.*, 1998a, b, 1999, 2001).

A final change in the environment that occurred in 1980 supported the selection of entrepreneurial faculty in biotechnology. This was the 1980 Supreme Court decision *Diamond* v. *Chakrabarty* (447 U.S. 303, 206 USPQ (BNA) 193 (1980)). The Court decided that a live, human-made microorganism was patentable. This decision allowed patenting of the results of recombinant DNA and monoclonal antibody processes central to biotechnology and supported the surge in biotech patenting and spin-off activity. As a result of these four events of 1980, most research universities now have a formal technology transfer process that facilitates the transfer of new inventions to industry (Liebeskind, 2001). Research carried out at universities can lead to discoveries, some of which are disclosed to the host institution. Some disclosures receive intellectual property protection, usually patents, but copyright and plant rights are also appropriate in some cases. Intellectual property can then be licensed. Some licenses are to existing companies; a few are to start-up companies. Some start-up companies involve the faculty researcher who made the discovery. These start-up companies, or spin offs, are highly prized by local economic developers because they tend to stay in the same state.

Faculty members are making decisions about how to disseminate the results of their research in this institutional milieu. They are deciding whether or not to collaborate with industry, whether or not to disclosure their inventions to their university, and whether or not to start a company based on their new knowledge. These choices are entrepreneurial in nature as they reflect an individual's recognition of an opportunity to commercialize an innovation. However, strictly speaking, while spinning off a company is clearly an entrepreneurial activity, patenting and collaborating may be considered entrepreneurial only if they are done in contemplation of starting a company (Gartner, 1988; Reynolds, 1994).

These decisions directly affect the productivity of the university's technology transfer program, a measure of outcomes per unit of input, since the quantity of outputs in the form of patents, licenses and spin offs is directly related to the quantity of inputs, that is how many disclosures are made. Jensen, Thursby and Thursby note that "many technology transfer office directors believe that substantially less than half of the inventions with commercial potential are disclosed to their office" (2003, p. 1272). Therefore, understanding how faculty make these decisions is critical. The purpose



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of this paper is to present findings about how faculty balance their ethical concerns, the norms of their discipline and their university, and their experiences as academic professionals when deciding whether or not to disclose new inventions, pursue patenting opportunities or spin-off a company.

## 2. Influences on faculty entrepreneurial decisions

There are three possible institutional influences on university researchers that could explain their decisions to patent and/or start companies. Researchers make choices within the context of constraints imposed by the university. Some constraints are policy-based incentives; others are based in the researcher's discipline. Less understood, however, are the constraints imposed by the norms of the university—the explicit and implicit rules of expected behavior. Further, constraints are also imposed by the individual's capabilities and the "publish or perish" paradigm.

The first possibility is that the individual's own beliefs and capabilities may be an influence on the choices that he/she makes, responding to the costs and benefits represented by norms, routines and myths within the university setting. Given that gaining outside funding for research is a fiscal reality for today's faculty members, a researcher who believes in the importance of commercialization might pursue industrial collaborations and funding for his/her work, seeking support for research that is more applied and likely to be patentable. A researcher who does not believe that universities should be involved with commercialization might choose research topics that are very basic and seek only federal funding.

The traditional academic ethos was described by Merton (1973) as having four elements: disinterestedness, universalism, organized skepticism and communism of intellectual property. Under this paradigm, competence, as measured by peers, is the only acceptable measure for career advancement. Findings from research are aproduct of social collaboration and are assignedto the community. Recognition and esteem emerge only from full and open communication of findings.

This so-called Mertonian ethos is in stark contrast to the emerging ethos of academic capitalism. Rather than publishing all results, academic capitalism emphasizes intellectual property rights and the public good attained through the commercialization of results. This ethos is supported by spirit of the Bayh-Dole Act and the intellectual property policies in place at most research universities.

Owen-Smith and Powell (2001a) have documented a multi-dimensional array of faculty attitudes toward academic capitalism. Others (Etzkowitz *et al.*, 1998) have also suggested that faculty attitudes vary considerably across these dimensions. Faculty express concerns about the loss of traditional values, especially openness. According to some, patenting has changed collegial relationships. Trust-based exchanges are now contract-based. Further, patents, based on science not validated by other academics, are becoming part of the equation that measures prestige, and therefore career advancement and funding (Liebeskind, 2001).

A second competing proposition is an evolutionary model of the transformation of the university over the last 20 years. This model projects a significant difference in the transformation of different disciplines or technology areas, particularly among life science researchers and other scientists and engineers. It assumes that life sciences inventions are more tacit in nature, leading to more spin-offs, because the professor would need to be continually involved to successfully commercialize the invention. This model also predicts a cohort effect, that younger faculty will be more entrepreneurial.

A third influence could be the institutional policies and procedures of the particular university where a researcher works. This, along with the second influence, represent the tug-of-war between the discipline and department/university described by Alpert (1985), Clark (1987) and Geiger (1986). Departmental norms could support traditional activities while university-wide policies and economic incentives may encourage more entrepreneurial activity.

The extant literature that focuses on the patenting decisions of faculty members does not control for attitudes about academic capitalism, academic quality, discipline or age, and instead focuses on the university's technology transfer policies and procedures. This forms a substantial basis for hypothesizing that institutional economic



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incentives may be important to understanding the level of entrepreneurship.

Jensen *et al.* (2003) present a game theoretic model of the interaction between the three major actors in university technology transfer: faculty, the technology transfer office and central administration. Based on a survey of 62 research universities, the authors conclude that faculty willingness to disclose is related to the stage of the innovation. They also find differences in disclosure rates related to academic quality. More importantly, this work emphasizes the dual agent role of the technology transfer office.

Feldman *et al.* (2001) have undertaken a study of the interaction between faculty patenting behavior and the organization of the technology transfer office. They believe that the history, culture and norms of the university play an important role in the university's approach to technology transfer. Their study is limited to three universities.

Owen-Smith and Powell (1998, 2001b) have interviewed 80 researchers in life sciences at two universities. They argue that faculty patenting decisions are shaped by their perceptions of the value of patent protection and the perceived costs of interacting with technology transfer offices and licensing professionals.

A fourth study, by Siegel *et al.* (2003), involved interviews with 98 entrepreneurs, and scientists and administrators at five universities. They concluded that organizational factors such as faculty reward systems and technology transfer office staffing/compensation practices influence the productivity of the technology transfer activities (and, by implication, the choices made by faculty researchers).

These four studies, while limited in scope, suggest that the institutional economic incentives offered by individual universities can affect the decisions made by faculty entrepreneurs about whether or not to collaborate with industry, disclose and/or patent their discoveries and spin off companies. However, since they do not compare these potential influences with the influences of individual beliefs, academic quality, the discipline or age, we still need to test these variables together.

## 3. Propositions based on the literature

The first proposition posed herein is that the norms and informal rules of the institution provide a context for the individual to make choices. The most important norm is the professor's beliefs about academic capitalism and the proper role of the university in the commercialization of inventions that emerge from university research. These beliefs constrain the entire decision-making process that a professor uses when evaluating research topics, assessing different funding sources and deciding how to publicize his/her results. I expected that the individual faculty member's attitude toward academic capitalism would be highly correlated with their behavior. Further, I expected that these beliefs would be deeply held and would not have fluctuated over a faculty member's career.

Academic quality is a second individual characteristic linked to technology transfer outcomes. The best researchers are also the most interested in the commercialization of their results, in direct contrast to those who claim that academic capitalism lowers academic standards in research. I expected that measures of academic quality would also be highly correlated with entrepreneurial behavior.

The second proposition is that the transformation of the university has been an evolutionary process resulting in differences by discipline and age. Life sciences has been more supportive of entrepreneurial behavior over the past 20 years compared to engineering. In engineering, some level of entrepreneurship has been evident for over 100 years at a fairly steady rate. Because of the influence exerted by the tacit knowledge inherent in biotechnology, I expected faculty in the life sciences to be more entrepreneurial than those in engineering.

The year of graduation for professors is also critical in this explanation because four key events happened in the 1980 timeframe, starting the transformation. Therefore, faculty who were trained after 1980 would be expected to be more entrepreneurial than their older colleagues.

The third proposition is the one most often cited in the literature. Here, institutional economic incentives, specifically the policies of the university and the technology transfer offices, form the environment for individual decision making. Including these incentives in this analysis will enable us to compare their influence relative to the competing propositions.



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### 4. Research design and data collection

Four data sets were used in this study. Briefly, a Web survey was administered to 420 faculty; 59 professors (14.0%) responded. Second, I conducted face-to-face interviews with faculty, using the same questions that were on the Web survey, with 39 faculty, 32 in person and 7 by telephone. These interviews were supplemented with meetings with the chief technology transfer officer and the Vice Provost for Research (or whomever was the senior administration official responsible for research affairs) at each of the 12 universities represent by the 98 faculty. At three universities, I met with a person affiliated with an incubator or business development activity, usually at the request of the Vice Provost for Research. And fourth, I collected secondary data about the universities from the Association of University Technology Managers (AUTM) and the National Science Foundation (NSF).

To elaborate on these data sets, I used a two-stage sampling scheme for this study. First, I chose 12 southeastern[1] universities from a population of the U.S. universities categorized as Doctoral/Research Extensive by the Carnegie Foundation for Higher Education.[2] Within this sample of 12 universities, I randomly chose (with replacement) to interview professors from 3 life sciences and 3 engineering departments. Each sampling stage is described below.

A Doctoral/Research/Extensive university is defined as a U.S. degree-granting and accredited university that grants 50 or more doctoral degrees per year across at least 15 disciplines. According to the Carnegie Foundation, in 2000 there were 130 Doctoral/Research Extensive universities nationally. I selected the 39 Doctoral/Research Extensive universities in the southeastern states. Since both students and faculty are recruited both nationally and internationally, these southeastern universities are representative of the entire population of 130.

To recognize the important distinctions in mission and funding sources, I further categorized these 39 southeastern Doctoral/Extensive universities into public (non-land grant), land grant and private. This categorization allowed me to compare faculty in universities with public funding to those in universities with the added tradition of public service (land grants). Further, I could compare these both to faculty at privately funded institutions.

I then chose the top four universities in each category, using three measures: the Faculty Quality Ratings in the 1995 National Research Council report (National Research Council 1995) across all life science and engineering departments; federally-financed R&D expenditures in FY2001; and the ranking of U.S. research universities by the Lombardi Program at the University of Florida[3] (Lombardi *et al.* 2002). The 12 universities are: Johns Hopkins, University of Virginia, Virginia Tech, University of North Carolina at Chapel Hill, Duke, North Carolina State, University of Georgia, Georgia Tech, Emory, University of Florida, University of Alabama at Birmingham, and Vanderbilt.

Within these 12 universities, the second-stage sampling frame was all full-time science and engineering faculty in the departments related to biotechnology and information technology, including full, associate, and assistant professors and research faculty. The departments were: biochemistry, biomedical engineering, (cell) biology, electrical engineering, mechanical engineering, and computer science

For each university, I used departmental websites to compile a master list of faculty in the life science disciplines as defined by the three departments listed above, and similarly for the engineering disciplines. To manage the fact that some departments are much larger than others, I chose a proportional number of faculty from life sciences and engineering for each university. Since the engineering faculty at the University of Georgia was the smallest in the sample universe at only 19, I randomly selected 19 professors in each discipline at each school. This yielded 437[4] names. In the same way, I chose 6 additional names at each university to interview in person, a total of 72 faculty, 3 in life sciences and 3 in engineering.

I then sent an email to the 437 professors with an explanation of the importance of the survey and requesting their cooperation. Some emailed back and asked to have their names removed from my list. A week later, I sent another email to the remaining 420 professors that again explained the project and contained a hyperlink to the survey. A week later, I sent a reminder survey to all. At the end of this process, I received 59 responses, a 14.0% response rate.



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Further, I interviewed 39 faculty members from the list of 72 compiled at all 12 universities, 32 professors in person and 7 on the telephone, a response rate of 54%.

## 5. Variables[5]

The *unit of analysis* is the individual faculty researcher in a science or engineering discipline at a top-ranked southeastern university. There are three *dependent variables*, each a categorical measure of a key aspect of entrepreneurial behavior. The three variables are dichotomous metrics that, taken together, represent a continuum of entrepreneurial actions by faculty. The three variables correspond to responses to the following three questions:

1. *Does the professor collaborate with industry?*
2. *Has the researcher ever filed or does he/she intend to file a patent on any discoveries resulting from his/her existing or past research projects?*
3. *Has the researcher ever or does he/she plan to spin off a company based on existing or past research projects?*

To test which of the five hypothesized influences on the level of entrepreneurship is most important, I collected data on a number of *explanatory variables*.

To test the importance of the context revealed by individual beliefs and capacity, I directly measured an individual's *attitudes toward entrepreneurship* by asking: On a five-point Likert scale, how does the individual rate himself/herself between the Mertonian ideal of the free exchange of ideas (1) and support for academic capitalism (5). The researcher's *perception of institutional entrepreneurship* is critical to assess how the individual reacts to the institutional culture. I asked: On a five-point Likert scale, how does the individual rate the university between the Mertonian ideal of the free exchange of ideas (1) and support for academic capitalism (5)? I asked a similar question about the individual's department. This scale represents my hypothesis about the range of attitudes prevalent in universities, and draws upon previous studies by Owen-Smith and Powell (2001a, b).

*Publication count* is used to measure of the excellence of the researcher, found to correlate with most measures of academic quality (Cole and Cole, 1973). *Total external research funding for the current academic year (2002–03) on which the faculty member was named*, another measure of the quality of the researcher's work, was also used. *Tenure* is a categorical control variable measuring whether or not the researcher holds a tenured position, is non-tenured but tenure track, or holds a non-tenured research appointment.

To test the evolutionary hypothesis, *discipline* was coded from the faculty's primary departmental appointment. The life sciences were coded together, as were engineering departments. An additional individual variable important to the evolutionary hypothesis is *year of graduation for the individual's terminal degree (usually Ph.D. or M.D.)*. This captures the influence of changes in the university with regard to technology transfer, without regard to age when receiving the degree. In order to assess whether the sample is representative of the universe of faculty, I also collected data on the *age* of each respondent.

Since the technology transfer office policies appear to influence technology transfer outcomes (Bercovitz *et al*., 2001), I included a number of measures of *Technology Transfer Office (TTO) policies and procedures* that provide economic incentives to faculty. Key policies are: percentage of royalties that accrue to the inventor and his/her laboratory, the percentage of disclosures initially submitted as provisional applications, and the percentage of patents applied for without a licensee.

Other variables that control for university policies are a set of dummy variables for the university itself, and a categorical variable for the type of university: land-grant, public and private.

## 6. Empirical results

There are 98 faculty members in the sample—59 faculty who participated in the Web survey plus 39 faculty who participated in the interviews. Since the statistical analysis shown in Table V does not control for response bias, Table IV show the similarities between the sample and the population of life sciences and engineering faculty at US research universities. In Table I, the respondents are distributed by department and university type compared to the characteristics of the population of



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Table I
Characteristics of the respondents compared to all surveyed

| | Sample ($n = 98$) (%) | All surveyed ($n = 420$) (%) |
|---|---|---|
| Department type | | |
| Life sciences | 51 | 50 |
| Engineering | 46.9 | 50 |
| Other | 1 | |
| University type | | |
| Land grant | 39.8 | 33.3 |
| Public | 32.7 | 33.3 |
| Private | 27.6 | 33.3 |

437 faculty from which they were drawn. In Table II, the respondents are compared by graduation dates, age, and tenure status with all US faculty based on published data.

As described above, attitudes about academic capitalism were measured on a five point Likert scale with "1" being agreement with traditional Mertonian beliefs about academic pursuits and "5" being agreement with academic capitalism As shown in Table III, the sample of 98 respondents displayed diverse opinions with nearly 20% identifying themselves as "1"s and another 20% as "5"s.

Table IV illustrates that this diversity was found without regard to university, university type, discipline type, number of publications, or age.

Table II
Characteristics of the respondents compared to all US faculty

| | Sample ($n = 98$) (%) | All US faculty (%) |
|---|---|---|
| Faculty graduation dates | | |
| 1990–present | 29.6 | |
| 1980–1989 | 39.8 | |
| 1970–1979 | 16.3 | |
| 1960–1969 | 14.3 | |
| Age of Faculty | | |
| Under 35 | 11.2 | 8.2 |
| 35–44 | 28.6 | 29.7 |
| 45–54 | 33.7 | 36.5 |
| 55–65 | 21.4 | 21.2 |
| 65 and older | 5.1 | 4.5 |
| Tenured faculty | 71 | 64 |
| Male tenured faculty | | 71 |

Sources: Age of US faculty: U.S. Department of Education, National Center for Education Statistics, 1993 National Study of Postsecondary Faculty. Tenure status of faculty: Digest of Education Statistics, 2001. Table 243. nces.ed.gov/pubs2002/digest2001/tables/dt243.asp.

Table III
Frequency distribution of respondents' attitudes about academic capitalism ($n = 98$)

| Academic capitalism rating (1–5) | Frequency | % | Cumulative percent |
|---|---|---|---|
| 1 Publication | 20 | 20.4 | 20.4 |
| 2 | 17 | 17.3 | 37.7 |
| 3 | 29 | 29.6 | 67.3 |
| 4 | 14 | 14.3 | 81.6 |
| 5 Academic capitalism | 18 | 18.3 | 100.0 |
| All | 98 | 100.0 | |

Most of the professors indicated that their attitude about academic capitalism had remained constant throughout their career. Seventy-one percent of the professors interviewed said that they had held their beliefs since graduate school. Of the 29% who said that they had changed, 82.8% went up on the academic capitalism scale, and 55% went up by 2 or more.

Fifty-one percent of the sample collaborates with industry, 50% had ever or planned to patent and 15.3% either planned to or had spun off a company. This compares well with Agrawal and Henderson's (2002) finding that one-half of MIT professors had never patented.

I used a logistic regression model to examine the relative significance of the variables upon faculty behavior, since the three dependent variables were dichotomous. For these models, I assumed that the variances are logistic and therefore used a *logit* model. I recognized that the coefficients cannot be interpreted directly. Using *logit*, the odds ratio was calculated by $e^x$, where $x$ is the coefficient. This gave a sweeping result as all other variables are held equal.

Using this technique, *logit* functions comparing the two values of each of the three dependent dichotomous variables were estimated with each hypothesis added one at a time. This resulted in a series of nested models. For example, the model testing both the discipline and year of graduation hypotheses is in the form:

$$\mathrm{PR}(K_i = P_1/Ki = P_0) = F\{\beta o + \beta_1(\text{Discipline})_i + \beta_2(\text{Year Graduated})_i\}$$

Table IV
Frequency distribution of academic capitalism attitudes ($n = 98$)

| | | | | |
|---|---|---|---|---|
| *By year of graduation* | | | | |
| Academic capitalism rating (1–5) | 1990s | 1980s | 1970s | 1960s |
| 1 Publication | 8 | 6 | 3 | 3 |
| 2 | 8 | 4 | 2 | 3 |
| 3 | 7 | 13 | 5 | 4 |
| 4 | 3 | 5 | 4 | 2 |
| 5 Academic capitalism | 3 | 11 | 2 | 2 |
| All | 29 | 39 | 16 | 14 |
| *By university type* | | | | |
| Academic capitalism rating (1–5) | Land-grant | Public | Private | |
| 1 Publication | 11 | 5 | 4 | |
| 2 | 4 | 4 | 9 | |
| 3 | 11 | 11 | 7 | |
| 4 | 6 | 4 | 4 | |
| 5 Academic capitalism | 7 | 8 | 3 | |
| All | 39 | 32 | 27 | |
| *By tenure status* | | | | |
| Academic capitalism rating (1–5) | Tenured | Tenure-track | Researcher | |
| 1 Publication | 11 | 8 | 1 | |
| 2 | 11 | 4 | 2 | |
| 3 | 21 | 5 | 3 | |
| 4 | 10 | 4 | 0 | |
| 5 Academic capitalism | 17 | 0 | 1 | |
| All | 70 | 21 | 7 | |
| *By type of discipline* | | | | |
| Academic capitalism rating (1–5) | Life sciences | Engineering | | |
| 1 Publication | 11 | 9 | | |
| 2 | 6 | 11 | | |
| 3 | 19 | 10 | | |
| 4 | 9 | 4 | | |
| 5 Academic capitalism | 6 | 12 | | |
| All[a] | 51 | 46 | | |

[a]One respondent was not included due to missing data.

Then, for each dependent variable, I chose a final model that incorporated the most important variables from all of the previous models. I chose the model that both improved the overall fit of the model, measured by the Wald $\chi^2$ statistic, the Akaike's Information Criterion (AIC), and the Cox and Snell $R^2$, and maximized the significance of the explanatory variables measured by *t*-statistics.

The coefficients from the final model for each dependent variable were expressed as $e^x$ so that I could evaluate them using the odds ratio interpretation.

The two-stage sampling scheme requires attention to the possibility of cluster-correlated data. The observations are not independent or identically distributed. Certain universities may be over sampled and others under sampled. Observations within each university are likely to be correlated. These characteristics can lead to underestimated standard errors for parameters of interest and test statistics with inflated Type 1 error rates. To manage these issues, I used a program designed to take the cluster correlations into account when estimating the parameters. In this case, the parameters are estimated using a logistic regression based on generalized estimating equations (GEE).

I found that for each increase of one point on the academic capitalism scale, a professor is 61.1% more likely to collaborate with industry, 63.4% more likely to patent and 407.1% more likely to spin off a company. These results are shown in Table V.

The level of peer-reviewed publications in the past 5 years, a measure of the academic quality of



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Table V
Logistic regression results

| Explanatory variables | Collaboration with industry: Final model | Collaboration with industry: Exp (β) | Patenting behavior: Final model | Patenting behavior: Exp (β) | Spin-off behavior: Final model | Spin-off behavior: Exp (β) |
|---|---|---|---|---|---|---|
| Academic capitalism rating | 0.477 (0.029)* | 1.611 | 0.491 (0.023)* | 1.634 | 1.623 (0.005)** | 5.071 |
| Tenure status | −1.996 (0.158) | 0.136 | | | | |
| Tenured tenure track | −1.968 (0.102) | 0.140 | | | | |
| Publications | 0.030 (0.218) | 1.000 | 0.057 (0.009)** | 1.058 | 0.029 (0.328) | 1.029 |
| Department type: Engineering | 0.745 (0.179) | 2.107 | | | 1.294 (0.160) | 3.649 |
| Degree year | −.233 (0.556) | 0.800 | | | | |
| Provisionals filed | | | | | | |
| Patent w/o licensee | | | −0.026 (0.072) | 0.975 | | |
| Revenue split | 0.049 (0.156) | 1.050 | 0.072 (0.045)* | 1.075 | 0.156 (0.017)* | 1.169 |
| University | −0.089 (0.283) | 0.915 | | | | |
| University type: | 0.539 (0.434) | 1.714 | | | | |
| Land-grant public | 1.101 (0.118) | 3.008 | | | | |
| Constant | −2.0976 (0.260) | 0.123 | −4.725 (0.018)* | 0.009 | −15.690 (0.003)** | 0.000 |
| N+ | 97 | | 97 | | 97 | |
| Wald $\chi^2$ | 24.40** | | 26.89*** | | 44.56*** | |

*$p < 0.05$; **$p < 0.01$ ***$p < 0.001$ (Probability values shown in parenthesis).

+One observation dropped due to missing data.

the individual professor, is also significant. An increase in publications yields a 5.8% increase in patenting. In addition, professors are 7.5% more likely to patent and 16.9% more likely to spin off for each percentage point increase in the revenue split they will receive.

I completed a content analysis of the transcripts of the interviews with faculty members as well as the comments sections from the Web survey. Sixty-nine faculty had 122 comments on patenting which I coded into 26 different reasons. I then collapsed the initial 26 types of comments into 5 reasons for patenting and 5 reasons for not patenting. I used these comments to look for patterns to explain the differences noted in the logistic regressions.

An individual's attitude toward academic capitalism is a strong predictor of his/her likelihood of collaborating with industry, having ever patented and having ever spun off a company. The reasons for patenting are significantly different from expected ($p < 0.05$, degrees of freedom = 16); the reasons against patenting are not significant. These findings are illustrated in Figure 1.

The higher an individual's academic capitalism rating, the more likely that person is to patent because of the market opportunities. Fifty-eight percent of "4"s and 50% of "5"s cite getting to market as the reason to patent. They made comments such as:

> "The bigger picture is that technology transfer from academic to industry isn't a trivial thing. There's a lot of stuff that gets published and it's hard for companies to separate the wheat from the chaff, to figure out where the nuggets of ideas are that will benefit the commercial marketplace. There needs to be a lot of interactive exchange across that boundary to make that happen."
>
> *Engineering professor, private university, 40 years old*

> "Scientists don't make or discover medicines. To make a drug or a medicine takes a company."
>
> *Life sciences professor, public university, 52 years old*

On the other hand, those with low ratings who patented did so because of the challenge (50%). One said:

> "A new challenge, a new world, a different arena. Once you are a tenured professor at a place like this, it's pretty clear what's going to happen down the road."
>
> *Life sciences professor, public university, 52 years old*

Those with middle to low academic capitalism ratings, "2"s and "3"s, cited duty and responsibility and colleagues and sponsors a total of 66% and 56%, respectively.



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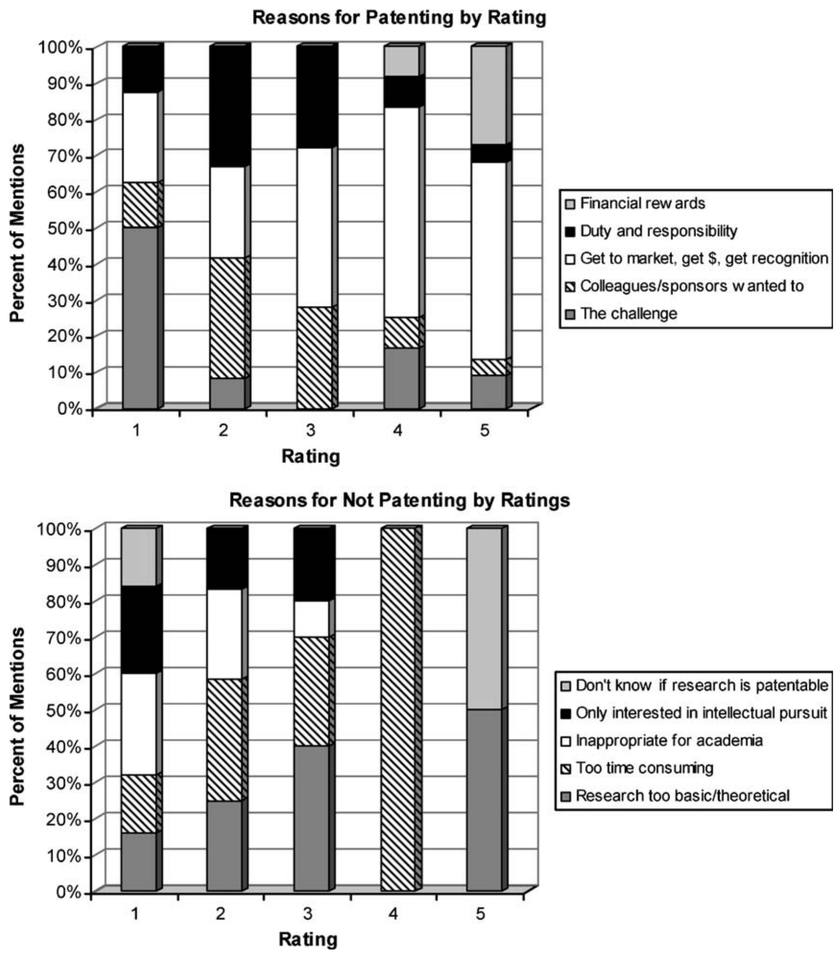


Figure 1. Reasons for patenting or not by attitudes about academic capitalism.

> "Patenting was not anything I ever thought about doing. In both cases, it was pressure from other people who thought there were really good ideas that should go out ... a collaborator from industry and other people in this department."
>
> *Life sciences professor, land-grant university, 39 years old*

Those who rated themselves as "1"s and "2"s said that patenting was inappropriate for academia 28 and 25% respectively.

> "The essence of industry involvement is to keep it secret. That's the core of competitiveness. The essence of university work is to make it public, or at least you can argue that. There's tension there, without a doubt."
>
> *Life sciences professor, private university, 61 years old*

Those with high self-ratings, "4"s and "5"s, who did not patent, most often cited not knowing if their technology was patentable (50% of "5"s), research that was too theoretical or basic (50% of "5"s) or patenting being too time consuming (100% of "4"s).

In addition to beliefs and attitudes about patenting, the faculty respondents also shared a number of ideas about the university milieu. Three stood out. First is the recognition that universities are in a financial crunch and revenue is critical. Second is the impact of conflict of interest and conflict of commitment policies on entrepreneurship. These policies were seen as depressing the entrepreneurial spirit. Third was the importance of tenure and promotion to a professor's career and the role of the department in those decisions. Tenure and promotion policies generally do not

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recognize patents and spin offs as valuable academic achievements, especially when compared to publications.

An important observation, however, was that whatever the university policies may be, the important decisions in an academic's career, tenure and promotion, are made at the department level. Therefore, if the department is lukewarm about technology transfer, this will affect the behaviors of the professors. Note that most respondents reported that their department had the same academic capitalism rating as they did—the mean of the difference between one's rating and one's department's rating was 0.2 where 0.0 means that the department and individual have the same rating. In contrast, only 37% thought that the university had the same rating as they did. The mean of the difference was 0.6, and the range was wider. Most believed that the university had a higher academic capitalism rating than they did.

## 7. Conclusions and policy observations

Professors in the sample have a range of beliefs in academic capitalism and these beliefs are linked with their behavior. The newer norm of academic capitalism is not universally embraced. In fact, those with the most extreme views, both for and against academic capitalism are found in all type of universities, in all six of the departments, in all age groups, and among all levels of academic quality. Given that the universities themselves are publicly embracing academic capitalism, and that faculty are required to disclose their inventions, the strength of the traditional norms is notable. This is especially true because the types of departments in this sample are those most likely to have research with practical applications.

The findings show that an individual's personal beliefs about the appropriate role of universities in commercializing technology are the single most important predictor of their actual behavior. Academic quality, as measured by publications, was also a critical factor in technology transfer participation.

The importance of technology transfer policies as one influence on professors' decisions about patenting and spinning off companies was revealed in the logistic regression analysis. The revenue split was a strong positive influence. Similarly, spinning off was most strongly influenced by the revenue split.

Conflict of interest and conflict of commitment policies may be reducing the number of spin-off companies. Fifteen percent of the sample said that they had spun off a company; another 8% had considered the idea and dropped it. Several professors who had spun off companies expressed the opinion that the conflict of interest and conflict of commitment policies were hostile to entrepreneurship and had a chilling effect. A review of the policies showed that many activities that would allow a spin-off company to benefit from the relationship with the university, the underpinning of spillover theory, are now often prohibited, while only a few years ago these activities were permitted with disclosure.

Based on this research, it would appear that the second transformation of the US research university, adding economic development to the established missions of teaching and research, is still a work in progress. While most major universities have added technology transfer offices, incubators, research parks and other institutions dedicated to the commercialization of university technology, it is apparent that some conflicts remain among these missions.

Further, university policies reinforce the perceived contradictions among the missions. Although the disclosure of inventions is required, and revenues arising from the successful patenting and licensing of the resulting intellectual property are split with the inventors, these policies are overshadowed by other, more fundamental incentives.

Tenure and promotion policies widely support publishing and research activities; patenting and spinning off companies are, at best, tolerated. Conflict of interest and conflict of commitment policies tightly control all potential actions that a faculty member with a start-up company might take, limiting the very collaborations between the company and the university that constitute the company's competitive advantage and the university's role in economic development.

University policymakers need to address the conflicting incentives on their campuses and continue the discussion of the underlying issues of the



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debate over academic capitalism. As long as the intellectual property, conflict of interest and tenure and promotion policies are not providing a consistent message for faculty about what is appropriate and desired behavior, the variety of actions shown in this study will continue.

Until patents and spin-off companies are recognized as evidence of scholarly contributions, and used and not just tolerated in the tenure and promotions processes, the willingness of the faculty to spend their time on such activities will be considerably reduced.

The conflict of interest and conflict of commitment policies pose a difficult problem. On one hand, it is important to manage the inevitable conflicts that arise, particularly from spin-off activities. On the other hand, it is also important not to create an environment of distrust and suspicion where all entrepreneurs are considered guilty until proven otherwise.

Above all, the implication for policy and practice is to remember that not all members of the university community support the ends of regional economic development and fewer still support the means. To maximize the spillovers from a university to the local and regional economies requires interventions at the beginning of the process to ensure that faculty understand the process, support the process and have the appropriate incentives to participate in the process. This needs to be done with sensitivity to the long standing academic ethics and the conflicts within the missions of the research university.

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## Notes

1. Southeast was defined as DE, MD, DC, VA, WV, NC, SC, KY, TN, GA, FL, AL and MS using the U.S. Census definitions for South Atlantic and East South Central Divisions of the South Region. http://www.census.gov/geo/www/reg_div.txt
2. http://www.carnegiefoundation.org/classification
3. The Lombardi Program ranks American research universities on nine indicators: total research, federally-funded research, endowment, annual giving, number of National Academy Members on the faculty, faculty awards, doctorates granted, post-doctoral appointees and median SAT scores.
4. Eleven schools times two disciplines, life sciences and engineering, times 19. For one school, no engineering departments, so only 19 chosen. $(11\times2\times19)+(1\times1\times19)=437$.
5. The complete survey protocol is available from the author upon request.



## References

Agrawal, A. and R. Henderson, 2002, 'Putting Patents in Context: Exploring Knowledge Transfer from MIT,' *Management Science* **48** (1), 44–60.

Alpert, D., 1985, 'Performance and Paralysis: The Organizational Context of the American Research University,' *Journal of Higher Education* **56** (3), 241–281.

Bercovitz, J.E.L., M.P. Feldman, I. Feller, and R.M. Burton, 2001, 'Organizational Structure as a Determinant of Academic Patent and License Behavior: An Explanatory Study of Duke, Johns Hopkins and Pennsylvania State Universities,' *Journal of Technology Transfer* **26**, 21–35.

Clark, B.R., 1987, *The Academic Life: Small Worlds, Different Worlds*, Princeton, NJ: The Carnegie Foundation for the Advancement of Teaching.

Cole, J.R. and S. Cole, 1973, *Social Stratification in Science*, Chicago, IL: University of Chicago Press.

Dueker, K.S., 1997, 'Biobusiness on Campus: Commercialization of University-Developed Biomedical Technologies,' Food and Drug Law Journal **52** (453).

Etzkowitz, H., 1983, 'Entrepreneurial Scientists and Entrepreneurial Universities in American Academic Science,' *Minerva* **21** (2–3), 198–233.

Etzkowitz, H., A. Webster, and P. Healy, 1998, *Capitalizing Knowledge: New Intersections of Industry and Academia*, Albany, NY: State University of New York Press.

Feldman, M.P., I. Feller, J.E.L. Bercovitz, and R.M. Burton, 2001, 'Understanding Evolving University–Industry Relationships,' in M.P. Feldman and A. Link (eds.), *Innovation Policy in the Knowledge-Based Economy*, Boston, MA: Kluwer Academic Publishers.

Feller, I., 1997a, 'Federal and State Roles in Science and Technology,' *Economic Development Quarterly* **11** (4), 283–296.

Feller, I., 1997b, 'Technology Transfer from Universities,' in J.C. Smart (eds.), Higher Education: Handbook of Theory and Research, Volume XII, Agathon Press.

Gartner, W.B., 1988, 'Who Is An Entrepreneur? Is the Wrong Question,' *American Journal of Small Business* **12** (4), 11–32.

Geiger, R.L., 1986, *To Advance Knowledge: The Growth of American Research Universities 1900–1940*, New York: Oxford University Press.

Goldstein, H.A. and M.I. Luger, 1997, 'Assisting Economic and Business Development,' in M.W. Peterson, D. Dill, and L. Mets (eds.), *Planning and Management for a Changing Environment*, San Francisco: Jossey Bass Publishers.

Hackett, E.J., 1990, 'Science as a Vocation in the 1990s: The Changing Organizational Culture of Academic Science,' *Journal of Higher Education* **61** (3), 241–279.

Henderson, R., A.B. Jaffe, and M. Trajtenberg, 1998, 'Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting, 1965–1988,' *Review of Economics and Statistics* **80** (1), 119–127.

Jenson, R.A., J.C. Thursby, and M.C. Thursby, 2003, 'Disclosure and Licensing of University Inventions: The Best We Can Do with the S**t We Get To Work With,' *International Journal of Industrial Organization* **21** (9), 1271–1300.

Kenney, M., 1986, *Biotechnology: The University–Industrial Complex*, New Haven, CT: Yale University Press.

Liebeskind, J.P., 2001, 'Risky Business: Universities and Intellectual Property,' *Academe* **87** (5), 49–54.

Lombardi, J.V., D.D. Craig, E.D. Capaldi, and D.S. Gater, 2002, *The Top American Research Universities*, Gainesville, FL: The Lombardi Program on Measuring University Performance, University of Florida.

Lowen, R.S., 1991, 'Transforming the University: Administrators, Physicists, and Industrial and Federal Patronage at Stanford, 1935–49,' *History of Education Quarterly* **31** (3), 365–388.

Merton, R.K., 1973, *The Sociology of Science: Theoretical and Empirical Investigations*, Chicago: University of Chicago Press.

Mowery, D.C. and N. Rosenberg, 1998, *Paths of Innovation*, Cambridge: Cambridge University Press.

Mowery, D.C., S.N. Sampart, and A. Ziedonis, 2002, 'Learning to Patent: Institutional Experience, Learning and the Characteristic of US University Patents after the Bayh-Dole Act, 1981–1992,' *Management Science* **48** (1), 73–89.

National Research Council, 1995, *Research-doctoral Programs in the United States*, Washington, D.C: Continuity and Change.

National Science Board, 2000, *Science and Engineering Indicators-2000*, Arlington, VA: National Science Foundation.

Owen-Smith, J. and W.W. Powell, 2001a, 'Careers and Contradictions: Faculty Responses to the Transformation of Knowledge and its Uses in the Life Sciences,' in S.P. Valias (eds.), *The Transformation of Work*, Amsterdam, New York: JAI.

Owen-Smith, J. and W.W. Powell, 2001b, 'To Patent or Not: Faculty Decisions and Institutional Success at Technology Transfer,' *Journal of Technology Transfer* **26**, 99–114.

Pisano, G., S. Weijian, and D.J. Teece, 1988, 'Joint Ventures and Collaboration in the Biotechnology Industry,' in D.C. Mowery (eds.), *International Collaborative Ventures in U.S Manufacturing*, Cambridge, MA: Ballinger Publishing Co.

Powell, W.W. and J. Owen-Smith, 1998, 'Universities and the Market for Intellectual Property in the Life Sciences,' *Journal of Policy Analysis and Management* **17** (2), 253–277.

Reynolds, P., 1994, 'Reducing Barriers to Understanding New Firm Gestation: Prevalence and Success of Nascent Entrepreneurs,' Unpublished paper, presented at the meeting of the Academy of Management, Dallas, TX.

Siegel, D., D. Waldman, and A. Link, 2003, 'Assessing the Impact of Organizational Practices on the Relative Productivity of University Technology Transfer Offices: An Exploratory Study,' *Research Policy* **32**, 27–48.

Slaughter, S. and L.L. Leslie, 1997, *Academic Capitalism: Politics, Policies and the Entrepreneurial University*, Baltimore, MD: The Johns Hopkins University Press.

U.S. Congress, O. o. T.A., 1984, Commercial Biotechnology, New York: Pergamon Press.

Zucker, L.G., M. Darby, and J. Armstrong, 1998a, 'Geographically Localized Knowledge: Spillovers or Markets?' *Economic Inquiry* **36** (1), 65–86.

Zucker, L.G., M. Darby, and M.B. Brewer, 1998b, 'Intellectual Human Capital and the Birth of U.S. Biotechnology,' *American Economic Review* **88** (1), 290–306.

Zucker, L.G., M. Darby, and J. Armstrong, 1999, *Intellectual Capital and the Firm: The Technology of Geographically Localized Knowledge Spillovers*, Cambridge, MA: National Bureau of Economic Research (NBER).

Zucker, L.G., M. Darby, and J. Armstrong, 2001, *Commercializing Knowledge: University Science, Knowledge Capture and Firm Performance in Biotechnology*, Cambridge, MA: National Bureau of Economic Research (NBER).





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