University Technology Transfer: An Introduction to the Special Issue

***Abstract*—In recent decades, there has been a substantial increase in university patenting, licensing, and research joint ventures with private companies. Technology incubators, science parks, and NSF-sponsored engineering research centers and industry–university cooperative research centers have also become ubiquitous at research universities. This special issue addresses the managerial and policy implications of these trends.**

***Index Terms*—Clusters, research park, startups, technology transfer.**

I. Introduction

IN RECENT decades, there has been a substantial increase in university patenting, licensing, and research joint ventures with private companies. Technology incubators, science parks, and NSF-sponsored engineering research centers and industry–university cooperative research centers have also become ubiquitous at research universities. Growth in these activities can be attributed to legislative changes designed to promote more rapid diffusion of technologies from universities to firms (e.g., the Bayh–Dole Act) and an expansion of public-private partnerships by the federal government (e.g., the U.S. Commerce Department's Advanced Technology Program and the Small Business Innovation Research Program) and in several states (e.g., Ben Franklin Technology Partners in Pennsylvania).

The rapid increase in university technology transfer has also attracted attention in the academic literature [1], since this trend has important managerial and policy implications. As a result, there have been several papers on university licensing, patenting, and startup formation. This emerging literature is interdisciplinary, with contributions from scholars in many disciplines, such as economics, sociology, political science, public administration, engineering, and in several fields within management, such as strategy, entrepreneurship, human resource management, and technology and innovation management. There is also some international evidence on this phenomenon. Finally, due to the complexity of the issues raised by the rise of technology transfer at universities, many authors have employed qualitative methods to address key research questions. This is entirely appropriate, given the difficulty of measuring and interpreting organizational phenomena.

II. Brief Literature Review

Some papers have focused on institutions that facilitate commercialization and entrepreneurship, such as technology transfer offices [2]–[4], science parks [5] and [6], and incubators [7]–[10]. Siegel *et al*. [3] assessed and "explain" the relative productivity of U.S. university technology transfer offices and reported that organizational practices explain a significant percentage of the variation in relative performance. Thursby and Thursby [2] reported that growth in licensing and patenting by universities reflects an increase in the willingness of professors to patent, not a fundamental shift from basic to applied research.

DiGregorio and Shane [11] concluded that the two key determinants of the rate of formation of university-based startups are faculty quality and the ability of the university and inventor(s) to assume equity in a startup in lieu of licensing royalty fees. The authors also found that a royalty distribution formula that is more favorable to faculty members reduces startup formation, a finding that is confirmed by Markman *et al*. [12]. DiGregorio and Shane [11] attributed this result to the higher opportunity cost associated with launching a new firm, relative to licensing the technology to an existing firm.

Other studies have focused on agents involved in technology transfer, such as academic scientists. These authors assess the antecedents and consequences of faculty involvement in university technology transfer, such as their propensity to patent, disclose inventions, co-author with industry scientists, and form university-based startups. A seminal paper by Jensen and Thursby [13] demonstrated that inventor involvement in university technology transfer potentially attenuates the deleterious effects of informational asymmetries that naturally arise in technological diffusion from universities to firms.

One of the first papers to study the entrepreneurial behavior of individual faculty members was Louis *et al*. [14].These authors analyzed the propensity of leading life-science faculty at 50 research universities to engage in various aspects of technology transfer, including commercialization. They found that the most important determinant of involvement in technology commercialization was local group norms, while university policies and structures had little effect on this activity.

III. Contributions to this Special Issue

The papers in this special issue of IEEE Transactions on Engineering Management focus on some unresolved research questions relating to the managerial and policy implications of university technology transfer. They are based on a variety of theoretical perspectives, such as the theory of the firm, institutional theory, resource dependence theory, agency theory, and organization learning perspectives. The authors use alternative levels of analysis (e.g., firm, university, region, and cluster) and a mix of quantitative and qualitative methods.

Gideon Markman, Peter Gianiodis, and Phil Phan analyze a growing phenomenon at American universities: university-based scientists who "bypass" their institution's licensing office, by privately selling or licensing scientific discoveries that were developed at their institutions. Their theoretical framework is

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agency theory. To test their agency-theory-based hypotheses, they collected data from a random sample of approximately 24000 scientists at 54 U.S. universities.

Their empirical results suggest that bypassing or "gray market" activity can be reduced through stronger administrative monitoring of scientists' activities and the adoption of licensing office practices that are more faculty-friendly. Interestingly, the study also shows that increased bypassing activity is associated with more valuable discoveries and heightened entrepreneurial activities. This result highlights the conundrum found in other studies: that universities emphasizing entrepreneurial startups can actually do better by reducing restrictions over intellectual property flows.

The study by Massimo Colombo and Evila Piva asks an important question: are academic startups different from other types of startups? To answer this question, the authors adopt an inductive approach, based on evidence from four theory-building case studies of Italian academic startups. They also draw on insights from the resource- and competence-based theories of the firm, in order to identify the factors that might differentiate academic startups from nonacademic startups. The authors use these qualitative findings, the results of prior studies, and the aforementioned theoretical frameworks to formulate a set of testable hypotheses relating to knowledge and funding gaps.

The paper by Dennis Leyden, Al Link, and Don Siegel is an analysis of the determinants of firm-level decisions to locate on a university research park. Research parks are a potentially important mechanism for university technology transfer and regional economic development. Unfortunately, there has been little theoretical or empirical evidence on decisions to locate on such a facility.

The authors fill this gap by using the economic theory of clubs [15] to model the decision to locate on a university research park. They conceptualize membership in the park as an invitation from the "club" (i.e., the research park) for the firm to join the park. A key empirical implication of the theoretical model is that firms conducting "higher quality" research are more likely to locate on a university research park, because this will enhance the company's ability to absorb new knowledge. An empirical test of this hypothesis was conducted, using Compustat data on the population of U.S. public companies that perform R&D. The findings indicate that firms locating on university research parks are indeed more research active than are observationally equivalent firms and also tend to more diversified, suggesting that these companies are potentially exploiting economies of scale in R&D.

Frank Rothaermel and David Ku use the knowledge production framework to assess the determinants of differential innovation performance in medical device clusters in the USA. The authors conjecture that cluster innovative performance is related to its endowment of financial, intellectual, and human capital. They test this hypothesis using comprehensive and detailed longitudinal data for the complete population of U.S. medical device clusters; and find strong support for the notion of spatial heterogeneity in cluster innovative performance. A key result is that research universities play an important role in this process. That is because these institutions constitute a source of knowledge spillovers via the transfer of human capital, which occurs mainly through students. It appears that when students are placed with these firms, they disseminate *tacit* knowledge within a cluster, which turns out to be a critical ingredient for innovative performance in a regional technology cluster.

In conclusion, the studies in this special issue shed new light on managerial and policy issues surrounding university technology transfer. Specifically, the papers reveal that a variety of theoretical perspectives and methods can be useful in explaining the behavior and performance of agents and institutions engaged in university technology transfer. Such heterogeneity is critical, given that the key stakeholders (i.e., academic scientists, university administrators, corporate managers, and entrepreneurs) have heterogeneous goals and objectives, as well as different norms, standards, and values. For instance, academics are primarily motivated by recognition within the scientific community, which requires that they quickly disseminate and publish their findings. This form of disclosure conflicts with goal of firms and entrepreneurs to maintain proprietary control over knowledge in order to maximize the financial return on investment in knowledge.

There also appear some severe bottlenecks in university technology transfer. A critical problem, from the perspective of the university, is that many faculty members are not disclosing their inventions. This implies that universities could be losing revenue because faculty are taking technologies "out of the back door," in order to avoid the university bureaucracy. Although universities are having difficulties managing and commercializing their intellectual property portfolios, they are making important economic contributions to their local regions, as suggested by papers on science parks and the medical device industry, respectively.

The papers in the special issue also highlight new research questions on this important topic. In terms of removing bottlenecks to effectiveness in university technology transfer, it would be useful to explore the role of nonpecuniary incentives, especially those relating to promotion and tenure policies at universities. These factors are clearly important determinants of the propensity of faculty members to engage in these activities. Finally, additional research is needed on the formulation and implementation of the strategic dimension of university technology transfer. A first step would be to develop a taxonomy of such strategies, which could then be mapped into indicators of performance. Given the importance of the human dimension revealed in these studies, the role of leadership in university technology transfer should also be examined.

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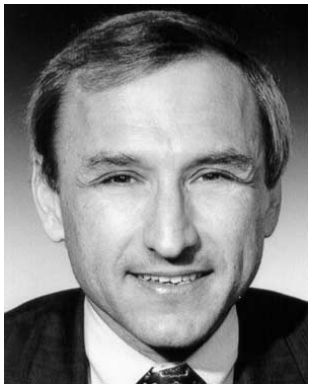

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